On Application of Open-Source Education Models to Nuclear Engineering

Technical Meeting on the Development and Application of Open-Source Modelling and Simulation Tools for Nuclear Reactors

June 23rd, 2022

How do we use open-source nuclear engineering tools effectively to educate new researchers/engineers?

- Traditional educator (lecturer)
 - teaching methods
- Code developer/maintainer (workshops)
 - teaching a code/API (and methods)



OpenMC Workshops

Past

- ANS Student Meetings
- NEA 4-Day course: April 25-28
- ANS PHYSOR Workshop: May 15
- ICTP-IAEA Summer School: May 25
- ONCORE Meeting: June 20

Upcoming

- NEA courses: Autumn '22, Spring '23
- M&C 2023

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The Carpentries

"Teaching foundational coding and data science skills to researchers worldwide."

- Python
- Git
- Bash
- R
- Pandas
- OpenRefine
- SQL





The Carpentries: A brief History

1995-96 - Greg Wilson "What Should Computer Scientists Teach to Physical Scientists and Engineers?" IEEE-CSE

- 1998 First software carpentry workshop by Brent Gorda and Greg Wilson
- 2004 Software carpentry materials openly published
- 2012 Sloan grant awarded
- 2014 Formal software carpentry organization founded by Greg Wilson
- 2018 merger into "The Carpentries"



The Carpentries: Publications

Founders are on over 50 publications related to software development and instruction

How to create and deliver lessons that work and build a teaching community around them.

- "Ten quick tips for teaching with participatory live coding" Nederbragt (2020)
- "Research this! questions that computing educators most want ... to answer. " Denny et. al. (2019)
- "Good enough practices in scientific computing." Wilson et. al. (2017)
- "Software carpentry: lessons learned" Wilson et. al. (2016)
- "Overcoming Social Barriers When Contributing to Open Source Software Projects" Steinmacher et. al. (2015)

"Best practices for scientific computing" Wilson et. al. (2014)



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The Carpentries: Scaling up



Learners

Workshops

Instructors



The Carpentries: Scaling Up



Application to NE



Tools/Codes

Software Carpentry

- Git
- Python
- Bash

Open-Source Nuclear Software

- OpenFOAM
- MOOSE
- OpenMC
- DRAGON
- ARMI

...



Teaching Formats

• Live

- \circ in-person
- \circ online
- hybrid

• Self-guided

- \circ tutorials
- \circ videos



Live Learning



Qualities

- Teaching environment
- Instructor training
- Local installations
- Teach to teach
- Rapid learner to instructor cycle
- Information gathering
 - surveys
 - quizzes
- Certificates/assessments
- Supporting organization



Qualities

- Learning environment
- Instructor training
- Local installations
- Rapid learner to instructor cycle
- Pair programming exercises
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 - quizzes
- Teach learners to teach themselves
- Certificates/assessments
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What we can build on

- Learning environment
- Instructor training
- Pair programming
- Information gathering
 - surveys
 - quizzes
- Teach learners to teach themselves
- Certificates/assessments



Learning Environment

"Ten quick tips for teaching with participatory live coding" Nederbragt (2020)

- Mitigate distractions
- Managing screen real-estate
- Provide space for learners to transfer knowledge
 - Google doc
 - Etherpad
- Instructor training is closely linked



What we can build on

- Learning environment
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More challenging aspects

- Local installation/distribution
- Rapid learner to instructor cycle
- Teach to teach
- Supporting Organization



Local installation

- Learners walking away with the software on their machine are more likely to use it after
- Difficult with deep software stacks
- Local Solutions
 - Conda
 - Docker
- Cloud
 - AWS
 - GH Codespaces





More challenging aspects

- Local installation/distribution
- Rapid learner to instructor cycle
- Backing organization
- Teach to teach
- Supporting Organization



Self-Guided



Benefits

- Accessible anytime
- Can be highly effective in combination with forums for support



Challenges

- Breaking down material into small chunks
- Provide easily accessible tutorial environments
 - Conda
 - GH Codespaces
 - AMI's
- Persistent material is challenging
 - Automation
 - Tutorial videos are effective, can be challenging to maintain for tools under development



Building a Pipeline



Building an Instructor Pipeline





Learner to Instructor Cycle

There are ways to shorten this timeline

- Mentor encouragement
- Helper/Instructor training



Inclusive Environment

"Overcoming Social Barriers When Contributing to Open Source Software Projects" Steinmacher et. al. (2015)

"...58 barriers identified to retaining contributors, 13 of which were social barriers..."

Workshops are an introduction to the project's culture – workshops are tied closely to the code's culture in our space



An aside on forums

"Overcoming Social Barriers When Contributing to Open Source Software Projects" Steinmacher et. al. (2015)

- Answer quickly, meaningfully
- Be kind
- Keep the community informed about decisions
- Create a newcomer's guide
- Identify mentors
- Users who post *are* contributors!!!



Conclusions

- Some things we should place higher value on
- Some things we need to learn to do from others
- Some things we need more resources for







My (very limited) Teaching Experience

Software Carpentry Instructor (2016 - 2018)

UW - Madison Guest Lecturer (2018, 3 lectures)

UChicago Instructor (2018 - 2019)

- Modern C++
- Python

