FacultyHack Events: Faculty-Focused Hackathons for High-Performance Computing Curriculum Development

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Abstract

Broadening participation initiatives are important for engaging underrepresented groups in science, technology, engineering, and math (STEM). Such initiatives help foster supportive and inclusive work environments that promote creativity and productivity. While there are initiatives that aim to engage students and faculty, opportunities remain to improve faculty support. Hackathons have proved to be a useful approach for student engagement. There are, however, limited insights into whether and how such events would also work for faculty aiming to develop curricula. This paper discusses the design of a faculty-focused hackathon event, FacultyHack, for curriculum development. We outline the logistics and structure for two past FacultyHack events, detail changes between events, and describe potential improvements and lessons learned.

CCS Concepts

• **Applied computing → Education**; • **Social and professional topics → Computing education**.

Keywords

Community Engagement, Curriculum Design, Hackathon, Time-Bounded Collaborative Event, Workforce Development

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1 Introduction

Broadening participation initiatives are important for engaging underrepresented groups in STEM. An example is Horizon Europe's Widening Participation and Spreading Excellence program [3]. A main objective of this program is to support less advanced research and innovation (R&I) countries to strengthen their R&I intensity and performance. Such initiatives also help encourage new partnerships and introduce new scientific curricula.

Among STEM skills, computing has established itself as a third pillar of science [19] as important as experimentation and theory for advancing the rate of scientific discovery. Computing makes breakthrough science possible by allowing one to study problems that are otherwise unapproachable due to, for example, prohibitive complexity, costs, or dangers. High-performance computing (HPC) resources have pushed the boundaries of science through their immense capabilities. For example, the TOP500's first exascale system, Frontier, made possible NASA's first-of-kind Mars lander flight simulations [11]. Using such resources, however, requires specific skill sets that are not commonly included in existing curricula.

Examples of two efforts aiming to build such skill sets while increasing participation of underrepresented groups are the Exascale Computing Project's Broadening Participation Initiative [10] and the National Science Foundation's Broadening Participation in Computing [1]. Both share a common goal of fostering diverse, supportive, and inclusive communities within the computing sciences. In addition to student opportunities, these efforts also provide faculty opportunities. For example, the Sustainable Research Pathways program [8] provides opportunities for faculty/student teams to collaborate with U.S. Department of Energy (DOE) National Laboratory scientists.

While excellent for faculty pursuing research, opportunities for faculty seeking support for HPC-related curriculum development are limited. Key challenges that faculty often face include that:

(1) existing programs may not be easily accessible (e.g., the DOE's Visiting Faculty Program (VFP)[1] requires a VFP research collaboration for teaching track eligibility),
(2) faculty may have little time to create new materials without an established research program,
(3) existing resource collections (e.g., HPC Carpentry [2]) may be overwhelming to faculty new to HPC and seeking mentorship to ease the process, and
(4) faculty often work on their courses independently.

A potential tool to aid faculty when building HPC-related curricula are hackathons. Hackathons are time-bounded events where participants form teams to collaboratively work on projects that are of interest to them [4]. Prior research on such events suggest that they could be suitable to address the aforementioned challenges.

Hackathons can be openly available for everyone (challenge 1) [18], serve as dedicated time to get work done (challenge 2) [16], provide access to mentorship (challenge 3) [14], and foster knowledge transfer within and across communities (challenge 4) [6]. However, existing studies have focused on the general public [18], individuals in corporations [16], students [14] and researchers [6] developing (software) prototypes [16, 18], learning new skills [6, 14], and growing their networks [14, 18]. Here, we instead use hackathons to support *educators* looking to *incorporate HPC resources into their curricula*, which has not yet been extensively studied.

Prior work has also shown that event design is not only important for participant satisfaction but can also influence hackathon outcomes, particularly in the long term [9, 13]. For such an event to have the desired impact on the creation of HPC-related curricula, it is necessary to carefully plan and execute events [15, 17]. In this paper, we discuss the design of two SGX3 [5] FacultyHack events, which were hosted in 2022 and 2023. We outline their logistics and structure (section 2), detail changes between events (section 3), and describe potential improvements and lessons learned (section 4).

2 The FacultyHack Model

The FacultyHack name is a combination of "faculty" and "hackathon". The design of the FacultyHack model is based on existing hackathon guidelines, primarily the HackHPC model [7] and hackathon planning kit [15]. Here, the basic HackHPC structure is used with adjustments made to address the challenges mentioned in the introduction (section 1). The subsections that follow discuss these adjustments, which are also summarized in Table 1.

2.1 Participants

FacultyHack and HackHPC teams consist of participants ("hackers") and 1 to 2 mentors. Rather than featuring 2 to 3 student participants, FacultyHack teams feature 1 to 2 faculty participants from 2- to 4-year degree-granting technical trade schools, colleges, and/or universities. Similar to HackHPC, we made a concerted effort to invite participants from minority-serving institutions (MSIs). Across past FacultyHack events, 76% of participating faculty were from MSIs predominantly designated federally as historically Black colleges and/or universities (HBCUs) in the United States. This is a result of successful recruiting through word of mouth and at the annual Association of Computer Science Departments at Minority Institutions (ADMI) symposium[2].

[1] https://science.osti.gov/wdts/vfp

Table 1: Key differences between FacultyHack and HackHPC.

Difference	FacultyHack	HackHPC
Participants per Team	1-2 Faculty	2-3 Students
Financial Support	Honorarium Travel Support	Prizes
Judged Competition	No	Yes
Mentor Matching	By Organizers	By Participants
"Hack" Day Activities	Course Development Resource Sharing	Mentor-Provided Challenges
Check-In Frequency	Once Daily	Twice Daily
Poster Presentation	Yes	No

2.2 Financial Support

Rather than prizes, FacultyHack events use travel support and honorariums to incentivize attendance, participation, and output during both the virtual FacultyHack sessions and an in-person conference poster presentation. To receive the honorarium, participants must attend all virtual FacultyHack sessions, attend a partner conference, present a poster on the revised course, and write a "travel report" for a community blog.

Participant support for past FacultyHack events was defined by the SGX3 workforce development supporting grant stipulations [12]. During these events, participants attended the SGX3 Gateways conference, participated in their poster session, and contributed to the SGX3 community blog.

2.3 Key Roles

FacultyHack events require 3 of the 4 roles used by the HackHPC model: organizers/staff, mentors, and sponsors. Judges are not necessary as the event does not center around a competition with prizes. Organizers and staff are professionals from academic, industry, and research organizations responsible for planning, logistics, recruiting, hosting, training, and funding. For the FacultyHack model, we differentiate between peer and technical mentors. Peer mentors are returning FacultyHack participants. Technical mentors are individuals with technical experience related to HPC. Similar to HackHPC, each participant team is paired with a technical mentor during the inaugural event and both a technical mentor and a peer mentor during subsequent events. Note, mentors may collaborate with multiple teams as backgrounds align. Sponsors are often HPC technology providers or educational institutions and groups who provide support in the form of, for example, HPC resources.

2.4 Procedure

FacultyHack events follow a procedure similar to HackHPC [7]. Key activities in the HackHPC procedure include:

(1) a planning phase to coordinate scheduling and logistics,
(2) a recruiting phase to identify individuals for key roles,
(3) creating a web page that will be updated during the event,
(4) inviting recruits to a common Discord server,
(5) hosting online training sessions,

[2] https://admiusa.org/

(6) hosting a kickoff meeting at the beginning of the event where the schedule and logistics are outlined, mentors pitch challenge ideas, and teams are formed,
(7) hosting morning and evening check-in sessions during "hack" days where teams present their current progress, challenges faced, and plans going into the next check-in, and
(8) hosting a final presentation session.

FacultyHack events begin with similar planning and recruiting phases, creation of an event page, and invitation of recruits to a common Discord server. Virtual sessions are then used to host a series of informational sessions, training sessions, team identity establishment sessions, and mentoring sessions. Examples of past training sessions include: "High-Performance Computing Overview", "Jupyter Notebooks in the Classroom for Reproducible Science", and "Oak Ridge National Laboratory Ascent Cluster Access" hands-on tutorials. Similarly, FacultyHack events conclude with a final presentation in the form of a conference poster presentation.

Notable changes to the HackHPC procedure relate to team formation, "hack" days, and check-in sessions. Whereas HackHPC participants decide which mentor(s) they'd like to join based on mentor pitch sessions, FacultyHack organizers work to identify mentor(s) with backgrounds closely related to participants and handle team formation. Whereas HackHPC "hack" days are used to work on mentor-provided challenges, FacultyHack "hack" days are for faculty participants and mentors to brainstorm ideas to improve existing courses, share resources, and work on deliverables. Whereas HackHPC check-in sessions are twice daily, FacultyHack check-in sessions are once daily in the evening. During the check-in sessions, teams provide progress updates, receive training, and have designated time to "hack" with their mentors. Between check-in sessions, teams coordinate amongst themselves to schedule any additional "hack" time needed.

2.5 Outcomes

During FacultyHack events, participants work to bring HPC technologies into their existing courses instead of on the HackHPC model's mentor-provided challenges. Similar to HackHPC, FacultyHack organizers provide guidelines for expected outcomes that participants should work towards during the event, which include:

(1) generating a completely revised course description with an implementation schedule,
(2) collaborating with an assigned mentor(s) who provide use cases, resources, and suggestions for next steps,
(3) identifying ways to secure robust access to HPC resources for research and instruction,
(4) identifying opportunities to collaborate with other HPC educators and technical personnel, and
(5) identifying an educator at their institution to collaborate with on HPC course revisions.

2.6 Professional Development

FacultyHack events add an element of professional development through a conference poster presentation. During virtual sessions, participants develop a plan to revise their courses alongside mentors. Afterwards, participants prepare a poster to be presented at a conference poster session. These posters document, for example, the revised course descriptions, implementation schedule, sample exercises, mentor suggestions, etc. During past FacultyHack events, faculty members prepared posters for the SGX3 Gateways conference[3,4]. In addition to knowledge transfer and networking opportunities, attending such a conference also provides participants with an opportunity to engage with the broader community.

3 Past Events

The model described in Section 2 has been applied in practice for two FacultyHack events hosted in 2022 and 2023. The subsections that follow detail past events and changes between events.

3.1 FacultyHack 2022

FacultyHack 2022 spanned 6 weeks with combined check-in and training sessions hosted one evening per week. Nine faculty members from 6 different institutions participated. For this event, five teams were formed with teams consisting of 1 to 2 faculty participants and 1 technical mentor each. Among mentors, 1 was from academia, 1 was from industry, and 3 were from the national labs. Note, peer mentors were not included being the inaugural event.

During the event, teams worked to incorporate HPC into a variety of classes including Data Mining and Machine Learning, Data Science I, Introduction to Programming for Science Majors, and Principles of Distributed Software Systems.

Common goals included developing lab exercises, identifying textbooks, and creating HPC-focused modules to incorporate into the courses. Teams were also invited to create posters about their work and present them during the poster session of the Gateways 2022 conference. One of FacultyHack teams also went on to win best poster for their work restructuring a Computer Programming II course. More details including resources, schedules, and teams are available online[5].

3.2 Year 1 to 2 Adjustments

From 2022 to 2023, FacultyHack events underwent several changes to improve the participant experience. Most notably, the time frame was reduced from 6 weeks to 1 week and training and check-in sessions were separated to allow faculty to focus on training before course development. This provided participants with dedicated time to align resources with their course needs, improving overall effectiveness. Another key change involved the integration of returning participants as peer mentors, bringing a deeper understanding of faculty needs to the mentoring process. Similarly, involvement of returning mentors from Oak Ridge National Laboratory and Texas Advanced Computing Center proved beneficial as they provided valuable insights, warnings about potential pitfalls, and resources collected across events. Honorarium requirements were also changed to include a travel report, offering more insight into the participant experience. These changes made for a more streamlined and enriched experience, fostering greater collaboration and innovation among participants.

3.3 FacultyHack 2023

FacultyHack 2023 spanned 1 week with training or check-in sessions hosted each evening. Seven faculty members from 6 different

[3] https://sciencegateways.org/gateways2022
[4] https://sciencegateways.org/gateways2023
[5] https://hackhpc.github.io/FacultyHack-Gateways22/

institutions participated. For this event, six teams were formed with teams consisting of 1 to 2 faculty participants, 1 technical mentor, and 1 peer mentor each. Among mentors, 7 were from academia, 1 was from industry, and 4 were from the national labs.

During the event, teams worked to incorporate HPC into a variety of classes including Computational and Mathematical Biology, Computer Networks, Cybersecurity, Introduction to Data Science, Introduction to Electrical & Computer Engineering, and Parallel Programming and Algorithms. Common goals included developing labs to demonstrate how students can run on cloud and traditional HPC resources, identifying textbooks, and understanding how to use heterogeneous HPC systems featuring GPUs. More details including resources, schedules, and teams are available online[6].

4 Potential Improvements and Lessons Learned

In this section, we outline our findings and discuss potential ways to improve the FacultyHack model. Before though, we would like to acknowledge that the model created a framework that allowed faculty to develop HPC-related curricula while addressing the challenges discussed in the introduction (section 1). It included the participation of individuals who might not otherwise have been able to receive support to develop their curricula (challenge 1). It created space in the busy schedules of faculty where they could focus on curriculum development (challenge 2). It provided access to resources in the form of webinars and mentorship related to curriculum development and answering technical questions (challenge 3). Additionally, it provided a space for faculty from different institutions, who aimed to integrate HPC into their curricula, to share experiences and challenges (challenge 4).

Central Resource Repository: FacultyHack teams are responsible for creating a GitHub repository to collect deliverables (e.g., course descriptions). However, teams typically hosted these on personal accounts. Considering creation of a centralized repository for deliverables and mentor-provided resources could be beneficial for organizing materials across events. An example could be having teams fork a template repository to be populated and submitted as a pull request. Such a repository would build a knowledge base that future teams can use to supplement mentor-provided resources.

Course Evaluations: FacultyHack mentors participate in mentoring sessions and may lead training sessions during FacultyHack events. However after events, FacultyHack mentors typically receive little feedback on course outcomes. Considering incorporation of mentors into the course evaluation process could be beneficial for providing mentor feedback. An example could be having teams prepare a course evaluation form whose results could be shared with the mentor as a deliverable. Such involvement would provide mentors with insights into what worked (or didn't) when taught.

Event Duration: FacultyHack 2023 spanned 1 week. For mentors and participants, this offered little time to analyze participant courses and mentor-provided resources. Considering a multi-week event where, for example, participants introduce courses and meet mentors during training sessions in Week 1 with mentoring sessions in Week 2 could be beneficial for improving knowledge transfer.

Faculty Mentor Programs: The Gateways conference offers a mentoring program for faculty seeking mentorship. However, HPC conference mentoring programs typically target students and early career professionals. Considering extension of other programs to broadly include faculty could be beneficial for helping meet faculty needs. Such an offering would provide faculty ineligible for early career programs an opportunity to be connected to a mentor(s) to, for example, help accelerate HPC curriculum development.

Guest Lectures: FacultyHack connects faculty participants to mentors from potentially different backgrounds and disciplines. Considering addition of a mentor guest lecture to the resulting course could be beneficial for encouraging knowledge transfer across communities. An example could be a guest lecture discussing how the mentor applies course material in practice. Such a lecture would provide students with insights into the "real world" applicability of what they're learning as well as potential career paths.

Peer Mentor Panels: Faculty participants are encouraged to return as peer mentors to help better meet faculty needs during mentoring sessions. Considering ways to share peer mentor experiences could be beneficial for further understanding faculty needs and lasting FacultyHack impacts. An example could be a panel for peer mentors to share the ideas and materials that have had the most impact on their courses taught since. Such a panel could also be used to highlight what past participants liked best, what could have been done different, and ways to build lasting relationships.

Professional Development Resources: FacultyHack connects faculty participants to experienced professionals from academia, industry, and national labs. Mentor-shared resources typically relate to the courses being designed. Considering addition of a component to share professional development resources could be beneficial for encouraging faculty growth. An example could be a training session highlighting opportunities for faculty to connect to other professionals with similar goals (e.g., visiting faculty programs).

5 Outlook

This paper discussed the design of a faculty-focused hackathon event, FacultyHack, for curriculum development. We outlined the logistics and structure for two past FacultyHack events, detailed changes between events, and described potential improvements and lessons learned. As of this writing, FacultyHack 2024[7] is in progress. Next, we plan to conduct an interview study with past participants to assess whether and how the resources developed have been integrated into their teaching. As a part of this, we aim to discuss their perception of the role of FacultyHack events in advancing their curricula. Such an understanding will be used to help inform changes and improvements for future events.

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