Developing a Successful HPC Mentoring Program at the IHPCSS

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ABSTRACT

The International High-Performance Computing Summer School (IHPCSS), established in 2010, addresses the challenge of training the next generation of HPC users by providing a platform for students and early career researchers to learn about HPC. The program includes technical training, science talks, and a strong mentoring component aimed at nurturing individuals, creating professional networks and building a supportive community. We describe the evolution of the mentoring program as it was expanded to become more formalized and inclusive, with dedicated sessions focusing on career development, interpersonal skills, and networking. Mentors and mentees are matched on the basis of shared interests and backgrounds, with a focus on career and work/life topics rather than technical mentoring. The IHPCSS also includes returning mentors, former IHPCSS students who return to serve as near-peer mentors, providing valuable insight into career progression in HPC. The key mentoring sessions are tailored to support participants in different aspects of their professional life. For example, the *Career Paths* session provides insights into different career paths, helping participants to make informed decisions about their future and the *Goal Setting* session helps participants set clear and achievable goals, fostering a strategic approach to personal and professional development. Through formal evaluations, student frequently express that the mentoring components are the most valuable parts of the IHPCSS. By considering the evaluations and feedback from each class, the organizers continuously improve the mentoring program. This paper captures our experience and lessons learned to provide a resource for other institutions interested in establishing similar initiatives in HPC or related fields.

CCS CONCEPTS

• **Computing methodologies** → **Massively parallel and high-performance simulations**; • **Social and professional topics** → **Computational science and engineering education**; **Informal education**.

KEYWORDS

high performance computing, mentoring, computational modeling, education and training

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1 INTRODUCTION

High-Performance Computing (HPC) is a multidisciplinary field which serves as the foundation for many areas of cutting-edge research science and computational modeling. However, training the next generation of HPC users continues to be a challenge. Often, HPC practitioners are domain specialists who are not exposed to HPC concepts and practices until graduate school or even later. Many institutions do not have dedicated HPC resources, local support, or training opportunities.

To address this lack of available training opportunities, the International HPC Summer School (IHPCSS) [1] was begun in 2010. The IHPCSS is an international collaboration between HPC experts in Australia, Canada, the EU, Japan, the UK, South Africa and the USA. It brings together over 80 students and early career researchers yearly to introduce them to the field of HPC.

In addition to teaching technical skills, the IHPCSS has identified community-building as a key component of retaining new researchers in HPC. Therefore, the IHPCSS includes a strong, integrated formal and informal mentoring program. This paper presents the evolution of the mentoring program at the International HPC Summer School from the event's inception to today, describing how it has been formalised and expanded over 14 years to create a unique experience.

The rest of this paper is organized as follows. First we provide an overview of the IHPCSS in Section 2, then we discuss the characteristics of effective mentoring in Section 3 and review related work in Section 4. Section 5 is dedicated to the foundations of mentoring

[1] https://www.ihpcss.org/

at the IHPCSS and Section 6 presents the evolution of the program. Section 7 discusses different aspects of creating community at the IHPCSS. We conclude in Section 8.

2 OVERVIEW OF THE IHPCSS

The International HPC Summer School began in 2010 as the European-US Summer School on HPC Challenges in Computational Sciences funded by the EU project DEISA [20] and NSF's TeraGrid [23]. The first event was organised in Italy and subsequently alternated between North America and Europe. Over the years, support for the European participants was handed from DEISA to PRACE, and then to EuroHPC JU [2] in 2024. The funding for US participants went through a similar transition from TeraGrid to XSEDE, and then to ACCESS [3]. Initial Schools accommodated 60 graduate students and post-docs. This was increased to 70 in 2013 when Japan joined, represented by RIKEN [24], and then to 80 in 2014 when Canada joined, represented first by Compute/Calcul Canada and then by the SciNet HPC Consortium [22] starting in 2018. In 2023, Australia joined the event through the Pawsey Supercomputing Research Centre [21] and the Centre for HPC [4] in South Africa participated as an observer. Overall, a total of 951 students have attended the Summer School. The event is usually held in July and the location is alternated between different partner organizations. Figure 1 shows locations of the past 12 events. The IHPCSS was cancelled in 2020 and held online in 2021. The next IHPCSS (the 14th) will take place from July 7 to 12, 2024 in Kobe, Japan.

The Summer School targets mostly PhD students, but also accepts MSc students and early postdocs who are already using HPC or have immediate need for it in their research. Applications are solicited from interested individuals and each partner organization evaluates the applicants in their geographic region to select their candidates. Typical acceptance rates are 50% or lower. The event includes lectures, hands-on sessions, science talks, a programming challenge, and an extensive mentoring program focused on career development, interpersonal skills, and networking. Mentoring is done both formally and informally; more details are given in Section 5. The students also have the opportunity to present their research during a student poster session and discuss their work with other attendees. Since attendees come from a variety of scientific background with only HPC as a common thread, students are forced to find new ways to present their work.

Throughout the week-long event, the students are exposed to concepts and techniques used in HPC as well as AI/ML and Data Science. They engage with computational scientists from multiple domains learning how HPC enables breakthroughs in scientific research. Attending the technical lectures and hands-on sessions gives students exposure to parallel programming methodologies, software engineering techniques, tools, and practical experience, gaining skills applicable to their own research. The schedules from all past events are available on the IHPCSS website, and include a list of all sessions run each year.

[2]See https://prace-ri.eu/ and https://eurohpc-ju.europa.eu/index_en/.
[3]See https://www.xsede.org/ and https://access-ci.org/.
[4]https://www.chpc.ac.za/

3 EFFECTIVE MENTORING

Mentoring experiences differ depending on the settings, goals, time frame, and level of formality. Creating a meaningful mentoring relationship over a short period of time is challenging, but that time limit can also inspire conversations that would not happen otherwise. Although every mentoring relationship is different, mentor and mentee need to authentically engage with one another for the mentoring to be effective [2]. Developing trust, sharing strengths and limitations, and creating a supportive environment that encourages everyone to speak freely and express their opinions without a fear of repercussions is essential in creating a sense of interpersonal comfort that enables more meaningful connections. It has also been shown that common interpersonal factors and deep-level similarities between mentor and mentee make both sides more receptive and open to provide and receive professional and personal support [3]. In other words, it is important to consider personal characteristics when matching mentors and mentees to facilitate personal connections. Other factors that contribute to establishing meaningful connections and thus enhancing the mentoring experiences are representation of diversity, and equity between both parties, which help to create a sense of belonging to the scientific community [4, 17].

4 RELATED WORK

STEM disciplines have the concept of mentorship embedded in their core—it is how scientific knowledge has been passed on for centuries, and how the next generations of professionals are being nurtured now [16]. Effective mentorship is an area of study in itself with varying terminology, depending on the context. Reviews of related literature between 1990 and the late 2000s [10] show the growing number of definitions for mentoring—increasing from 15 to more than 50. However, as noted in the consensus study report of the National Academies of Sciences, Engineering and Medicine on the Science of Effective Mentorship in STEMM [15] there are some commonalities among the definitions. A mentoring relationship is meant to help the individual grow, by providing professional and career development support, role modelling, and providing encouragement and emotional support. Mentoring connections are personal, build on trust, and reciprocal, providing new insights and perspective to both sides. Mentoring should be intentional and include planned activities with a mentor.

While it is understood that mentoring takes place beyond highly structured interactions [1], a proposed "Mentoring Toolkit" [18] highlights basic activities for an effective mentor relationship, including getting acquainted, setting goals, and clearly defining program scope and time frame.

Highlighted by [8], the role of mentor is sharing information in a blend of "reference resource", "guide to culture", and "advocate". While advocacy is typically beyond what is provided by IHPCSS mentors (since mentors are not at the same institutions as mentees), IHPCSS mentorship offers students outside of the HPC community access to cultural and technical understanding.

We acknowledge many other HPC and mentoring programs exist, but most of them either focus on technical mentoring (e.g., ACM Summer School on HPC [5] or Argonne's Seasonal Internship

[5]https://europe.acm.org/seasonal-schools/hpc

Figure 1: Map of IHPCSS locations.

Program [6]) or on non-technical mentoring (e.g., Women in HPC mentoring program [7] or the mentoring programs run at conferences such as SC and PEARC). The IHPCSS program combines both aspects.

5 FOUNDATIONS OF MENTORING AT THE IHPCSS

Here, we describe our mentoring philosophy and the current program in detail.

5.1 Mentoring Principles

Mentoring at the IHPCSS started with informal and intuitive elements added to the main program, and over the years evolved in response to participants' feedback and initiatives from the members of the organising committee. Since the formation of a dedicated mentoring subcommittee in 2015, mentoring at the IHPCSS now takes a formalised and informed approach.

The definition of mentoring adopted at the Summer School is very broad and simply states that it is a partnership between two people (for a set amount of time) based on mutual trust and respect. This is emphasised repeatedly before and throughout the event to create a safe and comfortable space for all participants.

The mentoring is focused on non-technical topics, including but not limited to career progression, personal resilience, work-life balance, dealing with difficult people and situations, time management, working remotely, and other kinds of work-related challenges. The mentoring program permeates through the whole event and includes both structured (dedicated sessions) and ad-hoc mentoring (over meals, social events, and at other arbitrary times).

The IHPCSS mentoring program distinguishes two kinds of mentors—staff mentors and near-peer mentors, called returning mentors. The near-peer mentors are former IHPCSS students who return to the event after a change in their career status. Every student starts with an assigned mentor; however, students are encouraged to seek other mentors as well and to talk to as many people as possible. They are also advised to make use of their mentor's network to make connections. Mentors are made aware of this as well, and are encouraged to connect their mentees with other staff members at the Summer School.

[6] https://www.anl.gov/education/seasonal-internship-program
[7] https://womeninhpc.org/community/mentoring

It is important to note that the IHPCSS staff members are not trained mental health professionals or personal coaches. The staff members are offered basic guidance on how to mentor in written form. Online orientation sessions are held for new mentors and returning mentors before the event. At the start of the Summer School, an introduction to mentoring session is held summarising the goals of the program and providing additional tips and best practices.

5.1.1 Mentor-Mentee Matching. The Summer School gathers over 80 students and 30 staff members from 5 continents, each with different scientific backgrounds and different life experiences. As mentioned in the previous section, it is easier to create a meaningful mentoring relationship when the individuals involved share some personal characteristics or interests. The mentor-mentee matching at the IHPCSS is based on survey results that students and staff complete several weeks before the event.

Students are asked to identify two scientific fields, two science areas of focus (e.g., molecular dynamics or climate modelling), two technical areas (e.g., GPU programming, software engineering, Big Data) and two work/life areas (e.g., work/life balance, moving to a new country, starting a family, improving relationships) that they would like to be mentored in. They are also asked about their current field of study, any particular software or tools they use in their work and which aspects of the Summer School they most look forward to. They can also provide a single question they most hope to get answered by a mentor during the event.

Staff who will be in attendance at the week-long Summer School are asked if they are willing to be assigned as a mentor to a group of students. If so, they are asked similar questions to the students, but they can identify an unlimited number of areas they are comfortable providing mentoring in. Staff members are also asked to provide a photo and short biograph (including both professional and personal interests), for inclusion on the event's internal page to make it easier for students to find specific mentors. Staff members for which it is their first time serving as a mentor at the IHPCSS are offered additional guidance on mentoring.

The information gathered in the student and staff surveys is then analyzed by a mentor-mentee matching algorithm. This algorithm first calculates a similarity score between each (mentee, mentor) pair based on overlap in their responses, with increased weight given to work/life overlap. The problem of matching mentors to

mentees, where each mentor can have multiple mentees, is a particular version of the stable matching problem usually referred to as the college admissions problem. We use our own implementation of the Gale-Shapley algorithm, which is proven to have an optimal and stable solution [9], in which mentors and mentees desire a match with as high a similarity score as possible. Once complete, we verify that no mentee is matched to someone at their institution, as we prefer mentees to benefit from new perspectives.

The matching is meant to provide a starting point for the mentoring experience. The students are advised to talk to as many mentors as possible, and peer-mentoring is also encouraged. Without this initial matching many students would not feel comfortable approaching the staff members and lose valuable time or miss out on meaningful conversations. If students feel their assigned mentor is a poor match, they can request a new mentor. This only happens once every few years.

5.1.2 Returning Mentors. One of the unique aspects of mentoring at the IHPCSS is the returning mentor program, where former student attendees are invited to attend the event as mentors. Near-peer mentoring has been shown to have benefits for both mentors and mentees [19, 25], and so we wanted to provide an opportunity for former Summer School students to come back and serve as near-peer mentors to new students. Their experiences since attending the Summer School are very valuable for the current students as they consider their next steps in HPC. Returning mentors are selected through a competitive application process designed to identify individuals with mentoring experience interested in giving back. Some of the questions included in the returning mentor application are:

- What is your field and area of focus?
- Describe why you are interested in returning to the Summer School as a mentor.
- Describe your experience as a mentor, either formal or informal.
- What do you believe you can contribute to attendees as a mentor?
- Describe any challenges you have faced which you would be prepared to discuss with mentees (e.g., having children, moving to a new country, taking time off).

In addition, we prefer mentors who have had a change in their career status, since students always have questions about how former students found their next employment position. In a typical year we receive 30–40 applications, of which 3–6 are selected. Each application is reviewed by multiple committee members against a rubric. Applicants frequently express that their time at the Summer School was very valuable, and they are eager to come back and provide a positive experience for a new cohort of students. At the Summer School, returning mentors are asked to organize the student poster sessions, server as mentors, assist during hands-on sessions, and give short talks describing their research and career paths since they attended the IHPCSS. Many of them changed their career trajectory and have experience of working both in the academic and commercial settings. To date 45 returning mentors have participated in the program.

5.1.3 Context Setting. The IHPCSS mentors, including the returning mentors, are open to having conversations about difficult issues, often using their own life experiences as examples. For the students to take full advantage of this opportunity, it is necessary to set the context and create a safe environment. This process starts before everyone arrives but fully kicks off with the introduction to mentoring session run on Sunday evening.

The goal of the Sunday session is to explain the mentoring program, set expectations and prepare the students for making meaningful connections. The staff members are not certified coaches or mental health professionals; therefore, it is important to set the context of the mentoring interactions and manage the expectations of all attendees, both mentors and mentees. The mentors are expected to share advice, guidance, support, and their perspective. The Sunday session emphasizes that mentors don't know everything, and simply try to answer students' questions to the best of their ability. Mentor advice is meant to guide mentees rather than force them into a certain direction. It is emphasized that mentors and mentees don't have to be in the same scientific field or have experienced the same challenges for effective mentoring. Near-peer and peer mentoring is also encouraged. Oftentimes people gain more confidence and encouragement from peer support. Listening and offering their perspective also improves interpersonal skills and offers opportunity for self-reflection.

We set no formal expectation about staying in touch after the Summer School. Staff members make it clear that students are welcome to communicate with them after the event, and students do sometimes stay in contact with staff members they connected closely with (who may or may not have been their assigned mentor). More commonly, students continue communicating with each other.

5.2 Mentoring Schedule at IHPCSS'23

To better illustrate different kinds of sessions included in the mentoring program at IHPCSS, we briefly describe sessions run during the most recent Summer School, held in Atlanta, GA, USA in July 2023. A description of how each of these sessions have evolved into this current form is discussed in Section 6. In addition to these formal sessions, the students are always encouraged to talk to as many peers and staff members as possible to expand their horizons and gain new perspectives on research and career opportunities.

5.2.1 Introduction to Mentoring. Every year, the IHPCSS starts with an orientation session run separately for student and staff attendees, as outlined in Section 5.1.3. In 2023, in addition to mentoring, this session covered the code of conduct, health and safety policy, and highlighted some key concepts (e.g., imposter syndrome, mental resilience, work-life balance, and networking). The goal for this session was to set up the mentoring framework for the rest of the week and make everyone feel welcomed.

5.2.2 Career Paths Session. In Atlanta, the first scheduled mentoring session was run on Monday morning and was focused on different HPC-related career paths. The initial presentation gave pros and cons of working in academia, industry, national lab/HPC center, and being a Research Software Engineer. It included a list of staff members who had experience working in each of those environments. This was followed by 3-minute lightning talks from

the returning mentors highlighting their career progression since attending IHPCSS as students. The goal of this session was to showcase different career paths available to the students and encourage them to think and talk to about their options with the staff members.

5.2.3 Goal Setting. During lunch on Monday the students were asked to find their mentor and have a goal setting chat in their mentoring group. To facilitate goal setting, the students were given a planning worksheet to help them figure out which technical sessions were of the most interest and what non-technical issues they wanted guidance on. Making this session a group activity creates a sense of community, makes the students aware of the issues faced by their peers, cultivates an environment of mindfulness and openness, and helps them establish common goals.

5.2.4 Career Skills Breakouts. Tuesday's session included breakouts for different career skills. The students could choose one of four themes: (1) Resume Review, (2) Presentation Skills, (3) Networking with an Elevator Pitch, or (4) Interview Tips. The activities for each theme were very interactive—from peer-reviewing CVs to practicing presentations, networking, and interview skills. Activities were guided by the mentors in groups of 6–8 students and included instructional handouts. The goal of this session was to provide the students with a chance to practice the relevant skills in a friendly environment and without unnecessary pressure.

5.2.5 One-on-Ones. The one-on-one session was scheduled on Wednesday before lunch and gave the students a chance to have a private conversation (~20 min) with their assigned mentor about topics of their choice—from career planning to work-life balance. These conversations are often continued after the session as well. We encourage students to start thinking about their one-on-one questions before arriving. If the assigned mentor does not feel comfortable offering advice on a specific topic, they are encouraged to connect the student with a staff member who can. Most students do not expect a clear-cut resolution to their problems, they simply want someone to listen and recognise their issues are real. Being taken seriously and gaining a fresh or broader perspective is often more valuable than receiving an answer.

5.2.6 Resource Fair. In 2023 the resource fair session was run on Thursday before lunch and many conversations continued during the meal. This session was another opportunity for the students discuss specific topics in a group context. Each mentor selects a single unique topic to focus on and stays in a specific location. Students walk around and talk to at least 2 or 3 mentors. Mentors have signs with their topics and most have handouts highlighting the key takeaways. Over the years many handouts have been created focusing on different topics (e.g., microaggression, networking, thesis writing, time management, science communication). These are available to students through the event website even if a topic is not covered in a given year, hence the name of the session—resource fair. One unexpected challenge is that students can feel awkward leaving a conversation, so we make announcements every 15 minutes to tell students to find a new topic to discuss.

5.3 Evaluation Process

Evaluation has been an essential aspect of the IHPCSS since its inception. It is conducted by a dedicated evaluation team, typically affiliated with the US partner (TeraGrid, XSEDE, ACCESS). It involves a variety of methods, including pre-, mid-, and post-event surveys and focus group interviews, which are crucial in assessing the effectiveness of the event and gathering feedback from participants. A member of the evaluation group is present throughout the event, ensuring seamless data collection and prompt response to emerging issues or feedback. Every year the data collected in the evaluation process is analysed and collated into a final report [5–7, 11–14].

The pre-event survey allows organisers to understand student demographics (including their background and aspirations) before the event, helping to tailor the experience to their needs. Mid-point surveys are used to assess the effectiveness of the approach and identify any on-going issues. The focus group interviews are conducted with students and staff on areas such as the mentoring process or gender, and provide valuable qualitative feedback. Post-event surveys of both students and mentors provide a comprehensive assessment of the impact of the IHPCSS, allowing organisers to capture participants' overall impressions and identify areas for improvement.

By systematically collecting feedback at various stages, organisers can assess the strengths and weaknesses of the IHPCSS and ultimately improve its quality and impact. This feedback loop ensures that the Summer School evolves and adapts to effectively meet the needs of its participants. The feedback gathered after each event has confirmed that, for many students, the IHPCSS is an important step in selecting their career path and helps them gain opportunities that would not be otherwise available.

6 HISTORY AND EVOLUTION OF THE IHPCSS MENTORING PROGRAM

Below we outline the evolution of the IHPCSS mentoring program, with changes made in response to staff observations and evaluation feedback. A graphical representation of which elements of the mentoring program were included in which years is given in Table 1. Where evaluation scores are given, they are on a 1-5 scale ('Strongly Disagree', 'Disagree', 'Neutral', 'Agree', 'Strongly Agree').

6.1 2010–2014

In the first several years of the IHPCSS, our approach rapidly evolved to meet the needs and feedback from students. Initially mentoring was entirely informal, but in 2013 we added dedicated mentoring times and encouraged staff members to think of mentoring topics.

We discovered students were reluctant to engage with staff, so we started randomly assigning students to a staff mentor. In the evaluations, students shared the feedback that they found the week-long opportunities for mentoring to be a positive and unique aspect of the School. However, this approach to mentoring was moderately rated: students gave a mean of 3.61 to 'I meaningfully engaged with a mentor at the Summer School' ('mentor engagement'), but 'I plan on keeping in contact with my mentor after the Summer School' ('stay in contact') had a mean of 3.05, and 'I am satisfied with the

Year	Informal mentoring	Formal mentoring	Breakdown of formal mentoring activities									Scheduled formal mentoring (min)
			Unstructured mentoring sessions	Orientation	1-on-1	RM career talk	Resource fair	Lunch in groups	1-on-1 (sighups)	RM career panel	Career workshop	
2010-2012	X											0
2013	X	X	X									180
2014	X	X	X									120
2015	X	X	X	X								150
2016	X	X	X	X								240
2017	X	X		X	X	X	X					300
2018	X	X		X	X	X	X	X				275
2019	X	X		X	X	X	X	X	X			285
2021	X	X		X	X	X	X	X		X	X	210
2022	X	X		X	X	X	X	X			X	230
2023	X	X		X	X	X	X	X			X	315

Table 1: Evolution of mentoring activities

student/mentor matching process' ('matching process') had a mean of 3.02, indicating room for improvement in making meaningful connections. Additionally, students provided comments indicating that many of them had good conversations with mentors, but would have preferred assignments based on common interests rather than random pairings.

Thus, beginning in 2014, staff and students were asked to select topics that they wished to be matched on, for both scientific domains (e.g., material science, molecular dynamics, geophysics) and technical areas (e.g., performance optimization, HPC workflows, hybrid MPI-OpenMP) and matched up before the IHPCSS. Students responded more favorably to this model for mentor matching, with a mean of 3.57 on 'stay in contact', a mean of 3.77 on 'matching process', and a mean of 3.92 on 'meaningful engagement'.

6.2 2015—Toronto, Canada

In recognition that mentoring at the IHPCSS was developing into a larger effort, a mentoring subcommittee was formed. This committee was separate from, but reported to, the IHPCSS organizing committee and was responsible for the planning and execution of all mentoring activities.

To continue to improve the quality of the mentor/mentee matches, and in recognition that the most valuable mentoring at the Summer School is usually in career and work/life topics, we modified our matching questions to include these topics (e.g., how to get along with your advisor, how to improve work/life balance, finding a non-academic job, etc.). Students selected their top two scientific, technical, and career topics, and were matched with staff members who selected all topics they were comfortable mentoring in.

In response to the 2014 recommendation, we provided more structure in the mentoring program. The mentoring guide was overhauled to include specific guidance about the role of mentoring at the Summer School, mentoring best practices, and the benefits of effective mentoring. We encouraged mentors and mentees to play an ice-breaker game before the Summer School to help break down barriers. At the Summer School, the first session on Monday was devoted to describing mentoring and extending the ice-breaker. On Wednesday, we had mentor/mentee one-on-ones. Finally, on Thursday, we had a few selected mentors advertise topics and encouraged students to talk with them. We also offered themed tables at lunchtime to facilitate discussions between students and staff.

Another major change in 2015 was the introduction of the returning mentor program. 50 students replied to our call for applications, from which 2 were selected.

We had an increase in student satisfaction with the mentoring program on the evaluations, to a mean of 3.75 on 'stay in contact', a mean of 4.18 on 'matching process', and a 4.18 on 'meaningful engagement'. 77% indicated they would be interested in returning as a mentor, and overall we received positive qualitative feedback on the role of the returning mentors. The evaluation report included the recommendation that we conduct an introductory session for mentors to clarify expectations, especially for staff members new to the Summer School.

6.3 2016—Ljubljana, Slovenia

We introduced an orientation session for staff on Sunday, before the welcome reception, based on the 2015 evaluations and our own observations that it was difficult to get staff members to read the mentoring instructions. At the orientation we explained our approach to mentoring, tips for connecting with students, and a schedule of the week's activities. Student orientation continued to be Monday morning, with one-on-ones on Wednesday and mentors discussing specific topics on Thursday. We held Monday lunch in mentoring groups, but removed table topics at other lunches to provide students more flexibility. We increased the weight placed the work/life category when matching mentors and mentees. We continued the returning mentor program, selecting 3 from the US and 2 from Europe. We received similar feedback as in 2015 on the evaluations, with a 3.85 on 'keep in contact', 4.09 on 'matching process', and 4.41 on 'meaningful engagement'.

6.4 2017—Boulder, CO, USA

We selected 3 returning mentors from the US, 1 from Canada, and 2 from Europe. Based on 2016 feedback from the returning mentors seeking more guidance, we held an orientation call before the Summer School explaining their role and expectations. We also asked them to prepare a pair of 2-minute lightning talks, one about their current research, and a second about their career path since the Summer School, to give students not in their mentoring groups an opportunity to learn more about them and potential career options.

To improve the student experience, we added a parallel orientation session Sunday night for students. This included an overview

of mentoring at the Summer School, a discussion of impostor syndrome and stereotype threat, and suggestions as to how to discuss your work and how to interact with mentors. On Monday we provided staff introductions and the returning mentor research talks, Wednesday we had one-on-ones, Thursday we held by breakouts on various work/life topics, and Friday was the returning mentor career lightning talks followed by free-form discussion.

Evaluation scores were similar to previous years: 'meaningful engagement' was a 4.29, 'stay in contact' was 4.05, and 'matching process' was 4.06. We did receive feedback that having a Code of Conduct would be useful, though no specific inappropriate behavior was noted.

6.5 2018—Ostrava, Czechia

In response to the 2017 feedback, we created a Code of Conduct for the IHPCSS to outline expectations and a reporting mechanism. All students and staff members must agree to follow it when they register to attend.

We expanded the returning mentor responsibilities to include organizing the poster sessions, and assigned each of the 4 poster sessions was assigned to a particular returning mentor. This both relieved responsibilities from other staff members, and provided the returning mentors with another opportunity for visibility. 4 returning mentors were assigned poster sessions and the fifth focused on helping struggling students during the hands-on sessions.

We modified our Monday mentoring session to include not only returning mentor research talks, but also the career path talk described in Section 5.2.2. During Thursday's session, we held a resource fair as described in Section 5.2.6. Staff members were encouraged to make and distribute flyers with their key takeaways on topics such as impostor syndrome or networking tips. The resource fair had the added benefit of presenting staff members as experts on certain topics, so that if students were unable to connect with them during the resource fair they could follow up later in the week.

Evaluation scores were slightly lower than previous years: 'meaningful engagement' was a 4.14, 'stay in contact' was 3.63, and 'matching process' was 3.72.

6.6 2019—Kobe, Japan

The 2019 IHPCSS was held in Japan, the first iteration held outside of North America or Europe. As a result, there was high interest in serving as a returning mentor, and we received 64 applications. Additional reviewers were recruited to help evaluate the applications. To standardize the review process, we produced a review guide which included a rubric with examples. We selected 2 returning mentors from Europe, 2 from the US, and 1 from Japan.

The 2019 schedule allotted an extra mentoring session, for a total of one each day. Monday continued to include returning mentor research talks and an overview of career paths. Monday lunch was held in mentoring groups, and we encouraged mentors to work with their mentees on goal-setting. Students often provided the feedback that the Summer School was overwhelming, and we hoped that encouraging specific goals for the week would enable them to get the most out of it.

We moved the resource fair to Tuesday, and then had students sign up for one-on-ones to continue the resource fair conversations on Wednesday. We hoped that the additional one-on-one time would enable students to extend their resource fair conversations, but we struggled with the logistics of getting students to sign up for timeslots, and some students didn't want to meet with many staff members, so some staff members had empty times. One-on-ones with each mentee and their assigned mentor were moved to Thursday, and Friday we kept the returning mentor talks and free-form closeout.

Our evaluations improved over the previous year: 'meaningful engagement' was a 4.37, 'stay in contact' was 3.96, and satisfied with the matching was 4.03. We also received feedback from mentors that they would prefer additional information about mentoring expectations.

6.7 2021—Virtual

No Summer School was held in 2020 due to COVID-19. In 2021, we held a Virtual Summer School, stretched out over 2 weeks but for only 3 hours per day. As with many virtual events, holding the IHPCSS online presented many challenges not faced by the in-person events. Because students were attending from North America, Europe, and Japan, the Summer School was essentially run twice, once at times conducive to Europe and Japan, and again at times convenient to North America. These high staffing requirements combined with no need for travel meant that we accepted 15 returning mentors in both regions to assist. We assigned virtual poster sessions to 4, and asked the others to assist in the hands-on sessions and the mentoring activities.

During the two-week program, we held 4 mentoring sessions: (1) Mentor group meetings, to replace the usual Monday lunch; (2) a career workshop, in which we presented the career paths information and then had students split into pairs to review each other's CVs; (3) the resource fair; and (4) a returning mentor panel, which replaced the returning mentor lightning talks. All mentoring sessions and social interactions were run in a customized gather.town virtual environment [8]. We also encouraged mentors to meet with their assigned mentees one-on-one at some point during the Summer School.

It is difficult to directly compare the evaluation results to other years given the change in modality, but we received good evaluations: 'meaningful engagement' was a 4.0, 'stay in contact' was 3.85, and 'matching process' was 3.73.

6.8 2022—Athens, Greece

In 2022 we returned to an in-person event. Since we were still very concerned about COVID, we created a COVID-19 Rules and Regulations document, requiring attendees to be vaccinated and requesting attendees test before travel.

We made some changes to the mentoring schedule based on 2019 and 2021. We kept the resource fair on Tuesday, so that students could make connections with staff members early in the week on work/life topics. We had found that relying on staff members to produce themed handouts was not effective, so the mentoring committee produced additional handouts on a variety of work/life

[8] https://www.gather.town/

topics, bringing the total number to 13. We used Wednesday's session to hold a career workshop, expanding on 2021. We began with a career paths overview talk, and then had students select one of four career topics (CV/resume review, networking and elevator pitch, presentation skills, and interview tips). We then held breakouts on each topic with handouts. For popular topics, we held multiple breakouts to keep the group size low and recruited returning mentors to help lead them. We had 7 returning mentors (4 from the US, 2 from Europe, and 1 from Canada). We retained the returning mentor research lightning talks on Monday and career lightning talks on Friday. One-on-ones were moved to Thursday.

Our evaluations were slightly lower than in 2019: 'meaningful engagement' was a 4.09, 'stay in contact' was 3.78, and 'matching process' was 4.11. We were not surprised our evaluations were slightly lower. Overall, students expressed that the pace of the Summer School was too intense and they felt burned out by the middle of the week. This had always been a concern with the Summer School, but we believe that returning to in-person events after COVID made the training particularly intense.

After the Summer School we held a debrief session with the returning mentors to gather recommendations for the following year, which we found very useful. Returning mentors appreciated the additional responsibility of the career breakout sessions, but shared that some students found staff difficult to approach during mealtimes and breaks. They suggested that returning mentor career talks be held earlier in the Summer School, since students are typically more interested in their career paths than their research. They also found that students frequently had vague goals related to the Summer School (e.g., "I'd like to learn more about MPI"), which made it difficult for them to feel satisfied with their experience.

6.9 2023—Atlanta, GA, USA

Despite expanding the scope of the Sunday orientation sessions for staff, we continued to receive feedback that new staff members were uncertain about expectations regarding mentoring. Therefore, we added a new staff orientation virtual call before the Summer School, to explain the expectations around mentoring and give new staff a chance to ask questions.

Based on the 2022 feedback, we attempted to reduce the intensity of the Summer School. We increased the lunch breaks from 60 to 90 minutes, giving students and staff more time to talk. We were more careful about requiring speakers to stick to the schedule. We ended in the mid-afternoon on Wednesday without having an organized evening activity so students would have additional downtime. In response to the returning mentor feedback, we asked our 3 returning mentors (from the U.S.) to combine their two lightning talks into a single longer talk, given on Monday. We created and distributed worksheets for mentors to use during the Monday lunches to guide the goal-setting discussions, and added information about setting specific and achievable goals to the Sunday orientation sessions. To make sure that staff members serving as mentors understood the mentoring schedule—sometimes mentors did not show up to activities—we added additional language to the mentor matching survey clarifying expectations. Detailed descriptions of the mentoring sessions for the 2023 IHPCSS are described in Section 5.2.

We wanted to formalize the 2022 COVID guidelines and expand it to include other situations, so we created a Health and Safety Policy that students and staff agreed to follow.

Our increased efforts to orient the staff were reflected in the evaluations: the score on "I was given sufficient guidance from the planning committee to adequately prepare for the Summer School" increased from 4.0 to 4.29. In general, scores returned to 2019 levels: 'meaningful engagement' was a 4.30, 'stay in contact' was 4.02, and 'matching process' was 4.17.

7 ESTABLISHING COMMUNITY AT THE IHPCSS

In the beginning, IHPCSS was organised without significant formal regulations around conduct. However, it is important to create an environment where participants feel respected, valued and supported. Such an environment allows participants to engage openly and authentically. It accelerates the development of a sense of community, cultivates a culture of collaboration and growth, and establishes psychological safety so that students can engages in the vulnerability needed for effective mentoring. This is particularly challenging given the time-limited nature of the Summer School.

Based on feedback from attendees, we have continued to make changes to improve community-building and increase participant comfort and security. Implementation details and evolution of major approaches to improve communication, educational platforms, Code of Conduct, and safety protocols will be outlined in a separate publication.

8 CONCLUSION

More than a decade of mentoring at the IHPCSS suggests the two key factors for creating an environment conductive to establishing meaningful mentoring connections are (1) clearly defined expectations (both for mentees and mentors), and (2) creating an environment conducive to intentional openness and vulnerability. We have deliberately worked towards these two goals, though information and orientation sessions and structured mentoring activities. The Summer School also benefits from the fact that students do not know each other or the staff before arriving. Unlike at their home institutions, where it can be difficult to obtain impartial mentoring because most potential mentors know details about their programs, at the IHPCSS students are able to feel more comfortable opening up, knowing that no one present has preconceived ideas about them or their departments. Additionally, the near-peer and peer mentoring add another dimension to the mentoring experience, by shifting the roles and responsibilities of the parties involved. The evolution of the mentoring program illustrates the usefulness of the systematic and rigorous evaluation process. However, it is most useful when attendee feedback leads to change.

We plan to continue to improve the IHPCSS mentoring program. One piece of feedback we frequently get is that students would like to see more diversity, particularly in race and gender, among the staff. In the past few years we have become very intentional about the overall makeup of the staff, and we plan to continue to improve in this area. Because the program is funded by academic projects and centers, we have also found it challenging to recruit industry representatives as staff. Since students are often very curious about

career paths in industry, we plan to more actively seek out industry engagement. The broad international scope of the Summer School, with 7 partners representing 5 continents, is frequently highlighted by students as a unique strength. We hope to continue this growth by including additional partners in the future. We have seen that the students and their backgrounds change over time; for example, more students now are using parallel codes developed by others than when the Summer School began. As a result, we anticipate that the specific mentoring activities will continue to change every few years in response to student needs and interests. Finally, convincing funding agencies of the value of the Summer School in preparing and welcoming the next generation of HPC researchers is a continuing challenge, as partners seek long-term stable funding sources to ensure the future of the Summer School.

We conclude with a few best practices for mentoring programs based on our experiences:

- Establish expectations for both mentors and mentees, including topics to cover and time commitment.
- Provide structured activities, especially early in the program, to create a framework for dialogue.
- If possible, provide a diverse set of mentoring environments to appeal to a broader audience.
- Periodically perform quantitative evaluations to inform change.

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