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LESSONS FROM A 2-HUB LIFE-SCIENCE TRAINING COURSE: FROM HEIDELBERG TO BANGALORE AND BEYOND

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Abstract

Technologies are rapidly evolving in the life sciences and other STEM areas. Advanced hands-on practical courses are key for life-science researchers to stay ahead of the game. Although the Covid-19 pandemic propelled/accelerated the transformation in remote training opportunities, it is clear that training in molecular biology methodologies requires and greatly benefits from hands-on face-to-face courses. Here we present a novel 2-hub course format, with teaching of cutting-edge technologies simultaneously in Germany (EMBL Heidelberg) and India (BLiSC in Bangalore). The format combines active-based learning on a scientific case study with collaborative exercises and networking that foster scientific exchange. We describe the digital technologies utilised in course design and delivery, and the multi-layered planning phase. Analysis of the participant and trainer feedback questionnaires demonstrates the benefits and challenges of the 2-hub format and illustrates the success of the course. The concept allows us to broaden our reach, while reducing overall CO_2 emission in comparison to a 1-hub course. We show that thanks to digital tools and collaboration of dedicated organisers, we can provide conceptual design and create sophisticated active-learner training opportunities with world-wide reach.

Keywords: 2-hub course, innovation, STEM, life-long learning, EMBL, technology-enhanced learning, advanced life-science training

Introduction

The European Molecular Biology Laboratory (EMBL) is an intergovernmental life science organisation, located at six sites in Europe. We conduct world-class life science research, provide training for students and scientists, and state-of-the-art research infrastructures for a wide range of scientific and experimental services. EICAT, EMBL's International Centre for Advanced Training, located at EMBL Heidelberg, Germany, provides advanced training for researchers in state-of-the-art technologies and fosters scientific exchange. During pre-pandemic times, EMBL was offering more than 60 onsite courses per year. Half of them happened in the EMBL Advanced Training Centre (ATC) in Heidelberg covering whole scientific technology workflows of experimental and computational methods. All EMBL Heidelberg designed courses apply learner centred approaches in combination with engaging activities to enhance discussions and networking. The course organisers, trainers and speakers are leading scientists in their research fields, from EMBL and world-wide.

At the beginning of the Covid-19 pandemic in 2020, we were forced to stop our onsite course programme. We managed to convert our events from onsite to virtual and successfully delivered 26 virtual courses from 2020 to 2022. These virtual courses contained theoretical and practical sessions paired with networking activities. With our innovative course design, we were not only able to provide live hands-on computational sessions but also successfully delivered training in experimental laboratory methodologies. At the beginning of the pandemic, we implemented a Moodle-based learning management system (LMS) called EMBLeCampus

(https://ecampus.embl.de), which has played an essential role in delivering virtual courses as well as the post-pandemic onsite courses (Zielonka et al. 2021). This LMS allowed us to utilise even more blended learning approaches during our virtual courses and since 2022 also in our face-to-face courses.

There were many benefits of the virtual courses, including time zone management by the LMS, Zoom as a virtual classroom and virtual machine-based IT set-ups for computational practicals. Since hands-on laboratory methodology is essential (Hofstein A. & Lunetta V.N. 2004) and cannot be replaced but rather complemented virtual training offerings we further improved our blended learning conceptual designs (Stoytcheva 2017). Paired with the possibility to allow increased impact and reach, for example to less wealthy laboratories (Parncutt et al. 2021), these developments led to the idea of a life science based 2-hub course including experimental laboratory and computational practical sessions. Here we describe the development of the EMBO Practical Course: Metabolite and species dynamics in microbial communities held 16-21 October 2022 at 2-hubs; in the ATC at EMBL Heidelberg in Germany and on the Bangalore Life Sciences Cluster campus in Bangalore (BLiSC), India. The central learning objective was that all participants will be able to apply the concepts and methodologies in their own research. Further we aimed at enabling networking among participants, speakers and trainers to further foster scientific exchange (source: https://www.embl.org/about/info/course-and-conference-office/events/mcd22-01/). The course received funding from the European Molecular Biology Organisation (EMBO) and was organised by the scientific organisers and the EMBL External Training team.

Criteria and recruitment of second course hub

In line with EMBL´s scientific programme and high demand for training in cutting-edge microbiology technologies, we focused this 2-hub course on the characterisation of microbial communities. The case study for this course was based on the publication Blasche *et al.* (2021) studying dynamics of microorganisms in Kefir over time.

In addition to the first course hub, the scientific training laboratory in the EMBL ATC, a second course hub was required. Scientifically, this second hub would require a molecular biology lab and instrument availability for DNA sequencing, microorganisms culturing and mass-spectrometry. This second hub needed to fulfil the following criteria and requirements:
a) Distance - it should be far enough to benefit from the CO_2 reduction based on shorter travel distances by the participants. At the same time the time zone difference should still allow for synchronised course sessions.
b) Commitment of co-organisers and trainers is key for a successful planning and course conduction.
c) Technological infrastructure requirements (machines, laboratory space, computational facility) - an equal set of technologies at the hub in order to conduct the same experiments.
d) The course topics overlap with the research interests of scientific institutes in the host and neighbouring countries.

The hub that fulfilled all criteria was the BLiSC in Bangalore, India. Both locations (Germany and India) reach a broad geographical distribution of audience, and allow reduced pandemic-related risks of long-distance travel. Additionally, the 2-hub concept had a positive impact on CO_2 reduction caused by air travel as the majority of participants travelled to the nearest hub.

Technologies in the 2-hub course

Technology enhanced learning has been evolving for many years. The Covid-19 pandemic has boosted further technological developments (Sen & Leong, 2020). While the isolation measures have been lifted now in most countries, the benefits of these technologies remain and provide opportunities for new training designs. The following technologies allowed us to hold the first international focused 2-hub course containing hands-on

laboratory experiments and computational analysis sessions.

Our LMS (EMBLeCampus) was used for content (protocols, literature etc) exchange and communication. The system offered the opportunity to manage a complex programme at the 2-hubs. DTEN screens (at the Heidelberg hub) for lectures, group and round-table discussions, and laptops during networking breaks were used to bring speakers, trainers and participants from both hubs together and to foster the cross-continent interaction. The Bangalore hub used a combination of beamer and laptops. In addition to the onsite lectures, we welcomed 3 international experts remotely to share their newest research. The computational practical sessions were implemented with the support of the EMBL-IT department on virtual machines from EMBL Heidelberg. This ensured equal access to the same software tools and packages from both sites. Prior to the course, there was a test run of all equipment and software to ensure everything would run smoothly during the course.

Conceptual 2-hub course design

This 2-hub course was designed to allow the participants access to cutting-edge technologies at two different locations. Both hubs needed to offer the same high-level access to methodologies, trainers and scientific lectures, as well as various scientific exchange and networking opportunities across both sites in order to achieve the long-term gains of the scientific content (Stryer et al. 2018). To accomplish this, the course programme was carefully planned to combine cross-site synchronised and unsynchronised sessions bridging the time-zone difference of 3.5 hours. Course content was shared via EMBLeCampus. Two weeks prior to the actual face-to-face course, the course started with a purely virtual on-boarding event for all participants including the organisers. A detailed outlook of the course programme was shared with the participants and access to the course content was granted (incl. protocols and literature). A first virtual ice-breaker activity on EMBLeCampus initialised communication and scientific exchange prior to the course.

The 6-day long course programme was mainly focused on hands-on experimental and computational practical sessions which were accompanied by theoretical lectures and networking opportunities within each hub but also cross-hub. The computational practical sessions, lectures including Q&A and various networking opportunities were synchronised via a virtual classroom to enhance the engagement. All scientific lectures were streamed to both hubs and were followed by a Q&A session moderated by a chair at each hub. The number of speakers as well as the number of questions asked by participants at both hubs was balanced to ensure equal chances for everyone and stimulated discussions.

Due to operational practicalities the laboratory experiments were conducted in an unsynchronised approach at the two respective sites. Precise timing of all course elements was crucial for this course to avoid gaps and discrepancies in the agenda, delayed talks and networking sessions at both hubs. However, participants had opportunities to discuss the protocols and results during the cross-site networking breaks. Computational practical sessions were carried out simultaneously at both hubs. Participants had remote access to pre-installed virtual machines provided by the EMBL-IT department.

All experiments were designed and adjusted to fit the schedule and were tested and timed by the trainers before the course to ensure precise timing for the live sessions and generation of back-up samples and datasets. Each hub also planned individual social activities.

Experimental case study

The kefir microbial community was chosen as a model system to profile its species and metabolite dynamics during fermentation. Experiments and data analyses were based on work of Blasche *et al.* (2021). Participants followed a complete experimental workflow from set-up of kefir culture, time point sampling, genomic DNA

extraction to 16S rDNA library preparation and sequencing using Oxford Nanopore Technologies (ONT), metabolomics analysis by mass spectrometry, and interaction mapping plating experiments. Furthermore, during computational practical sessions, obtained datasets were analysed with the emphasis on data management, reproducible data analysis and the FAIR principles. All experiments carried out during the course were in compliance with the laboratory biosafety level 1 (S1). Regular synchronised sessions were used to update the respective other hub about the experiments and its pitfalls, potential challenges and problems, and tips and tricks. This increased the cross-site interactions and was appreciated by the course participants.

Laboratory and experimental equipment and support

Having high quality video conferencing equipment with Zoom setup on both sites was crucial for successful delivery of cross-site theoretical lectures, computational practical sessions, discussions and networking sessions. Moreover, using the EPI2ME data analysis platform from the Genomics Core Facility at EMBL Heidelberg, we were able to live-stream to participants at both sites the start of the Nanopore sequencing run and the real-time identification of sequenced species and their phylogenetic relationships. This setup stimulated participants' interest in the technique and enhanced their curiosity and motivation.

International course audience

The main target audience for this course was PhD students and post-doctoral researchers who would apply the methods and knowledge that they learnt during the course in their home institutes. From a total of 101 applicants, 20 participants (10 for each hub) were selected by the scientific organisers based on their application and motivation letter summarising their current research and their need for the methods addressed in this course and promoting diversity, equality, and inclusion (DEI). We received 23 applications for the Bangalore hub and 78 applications for the Heidelberg hub. Notably, the Heidelberg hub received more applications from female than male scientists (45 female, 32 male, 1 did not want to disclose) than the Bangalore hub (10 female, 13 male). 96% of the scientists who applied to attend the course at the Bangalore hub were affiliated with a scientific institution in Asia. 66% of the applications for the Heidelberg hub were submitted from European host institutes. The Heidelberg hub still received 14 applications from Asia, although we promoted them to apply to the closest hub location in order to reduce the overall CO_2 emissions of the event [Figure 1] as airborne travel has significantly negative impact on climate change (Lee et al., 2021) and can represent great portion of carbon emissions in academia (e.g. Wynes and Donner 2018, Ahonen et al. 2021).

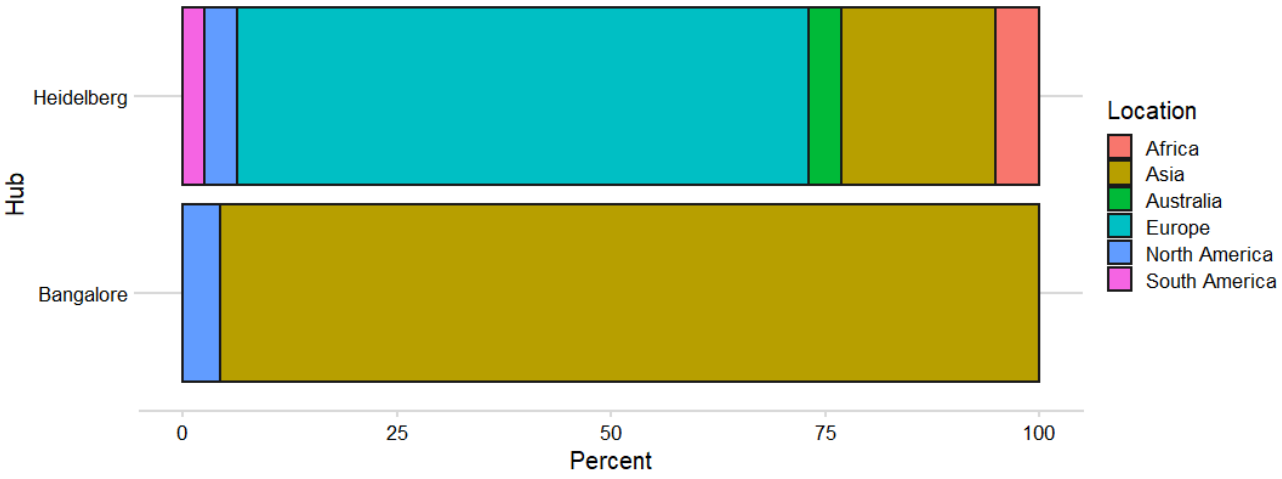

Figure 1: Course applications received for the Bangalore and Heidelberg hub. The graph illustrates the respective continent representation [%] in combination with the actual application numbers from the respective continent.

Fostering exchange and networking

The EMBLeCampus platform (Zielonka et al. 2021) was essential for communication, networking and providing learning material to everyone involved in the course. Participants had a chance to contact each other as well as the trainers, organisers and speakers before, during and after the course. Participants were encouraged to network during cross-site coffee breaks which were part of the programme. Participants were divided into several smaller cross-site teams for scientific exchange and networking Zoom meetings using course laptops. To further foster networking and team-spirit, we designed a “treasure hunt” team activity for the participants. Participants had the majority of the course to work on their challenges and results were submitted on the last evening and evaluated by the course organisation team. Results were presented on the last day of the course. All participants were rewarded with a small present to recognise their efforts.

Feedback questionnaires

To collect feedback about the course design and content, participants received a questionnaire after the course. A similar questionnaire was also sent to the scientific organisers, speakers and trainers to collect feedback from the trainer perspective. The feedback from participants and also speakers/trainers was very positive and illustrated the success of this new practical course format for life-science methodologies [Figure 2]. The course logistics at both hubs were mainly rated excellent or good e.g. the venue, EMBLeCampus, technical support [Figure 2].

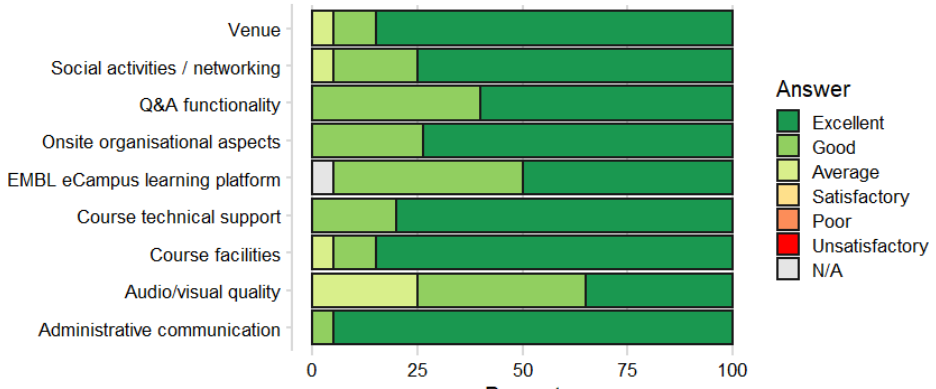

Figure 2: Participants' evaluation of various aspects and logistics elements of the 2-hub course.

The audio/visual quality rating received 25% average and 75% excellent or good. 17 of 20 participants stated that the balance of theoretical and practical content in this 2-hub course was about right. Most participants used the networking sessions to interact with remote speakers or speakers at the respective other hub instead of the forum or chat function in EMBLeCampus. 100% of the participants recommended the course according to the feedback survey. In addition, 100% stated that the topic was adequately covered and that this 2-hub course provided them with new information in their field.

We also analysed evaluation of key factors for the 2-hub course from the two groups, participants, and trainers and speakers, from the feedback questionnaires [Figure 3]. Results indicate that audio-visual quality (and internet connection) was mostly good, however, could be improved. Occasional technical issues such as internet connectivity disruptions and problems with audio were noticeable and addressed. Also, Q&A and discussions during computational practical sessions, have potential to be improved to provide better instant feedback to the trainers and overall flow of the session. The EMBLeCampus platform and the social and networking activities were very well received by both groups.

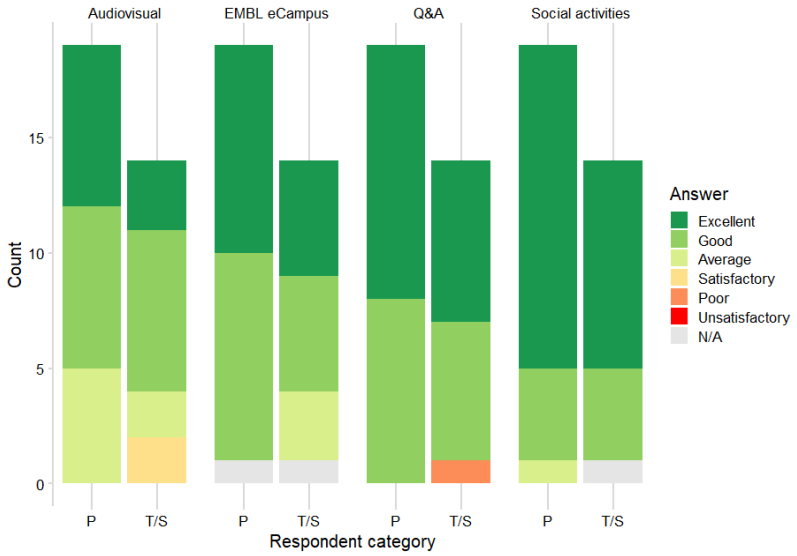

Figure 3: Questionnaire respondents' evaluation of key elements of the 2-hub course. Graph shows satisfaction of participants (P), and trainer and speakers (T/S) with an audio-visual setup (Audiovisual), usage of EMBLeCampus platform (EMBLeCampus), Q&A sessions (Q&A) and networking opportunities (Social activities). Count = number of received answers.

To assess the desired course learning outcome of enabling methodology application and collaboration we utilized a 6 months post-course survey. More than 70% of the participants indicated that they have successfully applied the course methodologies in their own research projects and have already or will in the close future publish their result. 85% stated that new collaborations were established during the 2 -hub course.

Conclusions and lessons learned

The first ever EMBO 2-hub practical course with experimental and computational practical sessions entitled "EMBO practical course: Metabolite and species dynamics in microbial communities" took place from 16 to 21

October 2022. 10 participants were located in the Bangalore hub and 10 in Heidelberg. Most of the sessions, consisting of computational practicals, lectures and networking, were held synchronously with the use of Zoom and other digital tools. Experimental laboratory practical sessions were unsynchronised and undertaken independently in each hub.

The 2-location set-up, with EMBL Heidelberg (Germany) as the European hub and BLiSC Bangalore (India) as the Asian hub, offered a concept that allowed cutting-edge technology training and access to world class speakers from two continents while limiting the necessity of inter-continental flights. The 2-hub concept saved 6.9 tonnes CO_2 in terms of speaker and trainer travel in comparison with a course based only in Heidelberg. The second hub provided a unique and empowering training opportunity for participants from Asia, many of whom would not have been able to join this course if it had taken place only in Heidelberg. Our data show that the two-hub concept is beneficial, sustainable and inclusive which is in an agreement with previous findings (Parncutt et al., 2021).

During the planning phase it was highly valuable to have regular update meetings with both hubs as well as carry out test sessions for the experimental workflow and the technologies for the general course delivery (lecture rooms, networking area, etc). Even though everything was tested before the course, there were unexpected challenges: i) Internet connection problems in Heidelberg that interfered with the speaker streaming to the Heidelberg hub, ii) the audio-visual system in Bangalore encountered problems due to heavy rain. Both challenges will need solutions in order to ensure the smooth delivery for a potential repeat of the course. The work involved in planning and preparing for this 2-hub format was more time consuming (appr. 40% increase) than a course hosted in the EMBL training facilities in Heidelberg only. This was a first-time event and a repeat of this 2-hub course would benefit from procedures and lessons learned and therefore require less time.

In 2020 the pandemic forced us to digitalise our hands-on practical course programme on advanced scientific technologies and methods. The investment into a Moodle-based learning management system and innovative virtual course delivery formats enabled us to develop new courses that further increased the international reach and impact of EMBL´s external scientific courses. We were able to empower international young scientists with training on the newest developments in the field of microbial communities. The 2-hub format allowed to reduce the overall CO_2 footprint of the course. Taken together, we presented a successful example of a novel hands-on scientific course model that has the potential to further increase our training reach.

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