October 2019

Training Course on Genetics in Support of Fisheries and Aquaculture Management

Supported by PANDORA H2020 project

ICES TRAINING COURSE REPORT

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

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1 Summary

There was a positive response to broadening the target community of participants to include those with some experience and knowledge of genetic/genomics, as well as those not working directly in the field. Dr Rita Castilho, the local scientific coordinator, and the simplified accessibility and local logistics, facilitated coherence and interactions among all participants and instructors throughout the 3-day course. The course comprised 5 interconnected components: (1) Introduction to fisheries and aquaculture genetics: including a consideration of aquatic genetic resource management, governance and policy drivers, overview of methodologies, and a critical consideration of applications of genetics/genomics to fisheries and aquaculture. (2) Introductory principles: familiarising participants with an understanding of population genetics, population genomics, stock structure identification and dynamics. (3) Recent advances: consideration of selected key recent developments of high relevance, including, environ-mental DNA, traceability of fish and fish products, the use of genetic tools for risk assessment and rapid species ID diagnostics, and genetics in monitoring control and enforcement. (4) Integration of genetics in fisheries science: incorporation of genetic data into stock assessment, including estimates of abundance using close kin mark recapture methods and population modelling, and genetics in ecosystem-based management. (5) Uptake and policy: the relevance of genetic data and outputs in policy development, with an illustration from a participant guest lecture, on the global status of aquatic genetic resources for food and aquaculture and steps towards an information system for farmed types (FAO, FIAA). (6) Course summary and feedback: an opportunity for course participants to provide feedback on course content and delivery, as well as to review course material and identify underrepresented areas. In addition to presentations, interactive sessions with plenary discussion, as well as data analysis and a practical demonstration of DNA-based species ID diagnostics, was included. In addition to the formal scientific sessions, there was many opportunities for social interaction at refreshment breaks and over lunch, as well as during a course dinner (held in a local restaurant, Thursday evening). The informality of the course, allowed for real-time modification to the programme, adapted to the needs of the participants, including group work focusing on solving particular management scenarios. In addition to the ICES SharePoint, Dr Castilho, coordinated a web-based platform, where all presentations, software literature, was embedded within a user-friendly facility. Full details are available on the course portal.

2 Background

Each year, the International Council for Exploration of the Sea (ICES), an intergovernmental organization that aims to enhance scientific knowledge of the marine environment and its living resources, offers training courses. For the first time, the 2018 ICES portfolio offers a 3-day course on the design and application of genomics in management and conservation of fisheries and aquaculture.

3 Context

The field of genetics and genomics is a topical and rapidly growing field of life sciences, and is possibly most familiar through its high profile application in human medicine and disease. The progressive deciphering of our own genomes enables a more targeted approach to tackling diseases and developing therapies, especially those shown to have a strong inherited or genetic component. In the field of fisheries and aquaculture, genomics is already enabling new approaches to tackling key challenges relating to sustainable exploitation, food security, welfare, and governance of our oceans. There are two primary levels that genomics have particular application: the first is to provide a source of tools to designate and monitor individuals, populations/stocks, species and communities, together with elucidating associated biological interactions such as the nature and intensity of predation. The fact that DNA is retrievable from whole fish through to highly processed products means that it is possible to trace products and individuals accurately. Such features, for example enable more effective design of pedigrees in aquaculture, the selection of favourable traits, as well as assigning individuals, stocks and species with unprecedented precision for use in applications from stock assessment through to tackling illegal fishing and promoting eco-certification. The second is the rather more prosaic, but fundamental role that population diversity ("genetic resources") play in the resilience, response and recovery of exploited populations to environmental change. It is only through the judicious identification and monitoring of population units or biological stocks, especially those features determined genetically, that it becomes possible to develop strategies to maximise and conserve genetic resources for adaptation to environmental change. Prominent applications of such thinking encompass, but are not limited to: the identification of species and stock entities for assessment and monitoring purposes, the shift and decline of fish populations due to climate change and overharvesting, impacts of farmed species on wild con-specifics, optimal designs for captive propagation and stock enhancement, and the achievement of management goals such as Maximum Sustainable Yield, to name just a few. While it is acknowledged that genetics can provide valuable support to the development and implementation of management and conservation strategies, the effective integration of genomic approaches into fisheries and aquaculture management is patchy, sometimes ineffectual, and underdeveloped. The course aimed to narrow the science-policy divide by focusing on the need to render genetics more responsive and relevant to management needs, as supported by recent conceptual and technical advances placed within the context of salient policy frameworks.

3.1 Objectives

The training course introduced participants to principles and practical application of genetics in fisheries and aquaculture including relevant evolutionary, quantitative- and population genetic theory. We focused initially on the relevance of genetics in the context of genetic resources and sustainability. This was followed by brief introductions to the major types of genetic and genomic tools that underpins management of aquatic natural resources, and how such approaches complement other management tools, together with a critical valuation of costs and benefits. We provided case studies throughout to illustrate in a practical way how genetics can help to address existing management and policy needs from capture and aquaculture fisheries. The course concluded with a consideration of how to facilitate links between science and policy, and the effective uptake and implementation in management of aquatic genetic resources. Three key components encapsulated course design: theory, to familiarise students with salient evolutionary and genetic principles, application, to demonstrate design and impact of genetic and genomic tools, and strategy, to promote application and uptake in management and conservation. The aim was

to equip participants with an understanding of genetic concepts and methods, with some critical evaluation of the alternative approaches, as well as opportunities for effective integration with existing methodologies, such as population modelling, risk assessment and oceanography.

3.2 Level

Following only a limited uptake by potential participants in 2018, it was decided for the 2019 course to broaden the target community, beyond those with no or limited experience/knowledge of genetics and genomics. The course was designed to target a broad community, including those with some experience in genetics/genomics, as well as those who are less familiar. Importantly, the training strategy will be highly interactive, thereby benefiting from a diversity of experience and expertise. We aim at people with a keen interest in how and when to apply evolutionary and genetic principles and tools to management issues, within the context of sustainability. We target students, fisheries/aquaculture scientists, fisheries/aquaculture managers and stakeholders involved in fisheries genetics and those more directly engaged in aquaculture management and policy decision-making. Strategies to facilitate impact and uptake of available knowledge and tools were prioritised. The mixture of backgrounds, motivation and expertise in the field worked well, with enhanced opportunities for participants to learn from each other. It is difficult to judge the impact of the change in title of the course from "Genomics" in support of fisheries and aquaculture (2018) to "Genetics" in support of fisheries and aquaculture. However, the increase in participant engagement, and uptake of the course, reflective possibly, a more general understanding and identification with the revised title.

4 Course Programme, Product, Deliverance and Instructions

4.1 Programme

See Table 1 attached

4.2 Course products

PowerPoint presentations; web-based platform accessible on http://rcastilho.pt/ices_2019 created and maintained by Dr Rita Castilho; plenary discussions; Group work; practical demonstration of DNA-based species ID diagnostics; plenary demonstrations of population modelling and data analysis; Hands-on data analysis using Population Genetic software and R.

4.3 Deliverables

- An understanding of the context and need to deploy genetics/genomics in aquatic resource management
- Ability to match specific genetic tools to a range of fisheries and aqua-culture applications
- Ability to design studies across a range of management scenarios
- Ability to conduct salient population genetic and genomic data anal-yses and inferences
- Introduction to core literature and major developments in the field, in-cluding contemporary advances
- Demonstration of informative case studies to illustrate methodologies and applications
- Ability to critically evaluate alternative genetic approaches and to facil-itate their integration with classical approaches where relevant
- An understanding of how to facilitate uptake and implementation of genetics in aquatic resource management
- Availability of software resources to facilitate application to additional scenarios
- Establishment of a network of practitioners with an interest in the field for ongoing interaction and consultation

4.4 Course instructors

Gary Carvalho, Bangor University, UK

Jann Martinsohn, Joint Research Centre, European Commission

Ernesto Jardim, Joint Research Centre, European Commission

Einar Eg Nielsen, DTU Aqua, Technical University of Denmark

Sarah Halyar, Joint Research Centre, European Commission

Rita Castilho, University of Algarve, Centre of Marine Science, Portugal

4.5 Recommendations

Based on the survey feedback following completion of the course, and within the Course Summary session (Part 6; Table 1), some key recommendations arise:

- to retain the breadth of eligibility and target community, including those with and without direct experience of genetics/genomics
- to enhance the opportunities for group work, and over longer sessions
- to reduce the length of individual presentations
- to lengthen the course, to possibly for days, with days of shorter duration
- to better target and identify essential reading material from the wider list
- to increase opportunities for hands-on data analysis and demonstration
- where possible, to ensure that all PowerPoint presentations are available in advance
- to retain and develop the additional bespoke platform containing presentations, literature, datasets and software, for ease of navigation and use
- to consider additional case studies from other parts of the world, especially tropical regions
- to enhance the consideration of ecosystem level processes in the context of genetic resource management
- to retain the balance of effort consideration to wild capture fisheries
- to retain opportunities that maximise participant and participant-instructor interaction, with 30 minutes refreshment breaks, one hour shared lunches, and at least one course dinner (non-mandatory, and extra cost)
- a consensus that the course should be repeated, possibly in 2 years' time

Annex 1: List of participants

Name	Institute
Amanda Lazdina	Institute of Food safety, Animal Health and Environment "BIOR"
Daniel Lucente	Food and Agriculture Organization of the United Nations (FAO) Department of Fisheries and Aquaculture, Aquaculture branch (FIAA)
Franziska Schade	Thuenen Institute of Baltic Sea Fisheries
Iker Pereda	AZTI - Tecnalia
Ingrid Tulp	Wageningen Marine Research
Iraide Artetxe-Arrate	AZTI - Tecnalia
Kristin Helle	Institute of Marine Research, Norway
Marine Cusa	University of Salford School of Environment and Life Sciences
Miso Pavicic	Institute of Oceanography and Fisheries - Laboratory of Ichthyology and Coastal Fisheries
Nikolai Klibansky	Southeast Fisheries Science Center NOAA - Beaufort Laboratory
Ole Thomas Albert	Institute of Marine Research - Frem Centre
Saemundur Sveinsson	Matis – genetics
Sandra Martins	Portuguese Institute for the Sea and Atmosphere - IPMA
Sara Francisco	ISPA Instituto Universitário, MARE - Marine and Environmental Sciences Centre
Sara Maggini	Bangor University - School of Natural Science, Molecular Ecology and Fisheries Genetics Laboratory
Térence Legrand	Aix-Marseille University / OSU Pytheas / Mediterranean Institute of Oceanography (MIO)

Annex 2: Agenda

	Tuesday 17 September		Wednesday 18 September		Thursday 19 September
08.30	COACH COLLECTION: CENTRAL FARO In front of main bus station, Faro, beside hotel EVA (see: Shuttle http://rcastilho.pt/venue/index.html)	08.30	COACH COLLECTION: CENTRAL FARO In front of main bus station, Faro, beside hotel EVA (see: Shuttle http://rcastilho.pt/venue/index.html)	08.30	COACH COLLECTION: CENTRAL FARO In front of main bus station, Faro, beside hotel EVA (see: Shuttle http://rcastilho.pt/venue/index.html)
09.20-10.00 10.00-10.30	Welcome and introductions (**GC**) Instructor introductions: (GC, RC; SH; EN; JM; EN); Participants introductions: Host welcome and local plans (RC) Course design and overview what is it we want to achieve in the ICES course? (**GC**)	09.00 09.15	Overview and update of Day 2 (GC/RC) 2.7 DATA ANALYSIS I: Population genomics and population connectivity (**SH**/EN/RC) ~ 1. 15 h	0900 09.15	Overview and update of Day 3 (GC/RC) PART 4: INTEGRATION OF GENETICS IN FISHERIES SCIENCE – introduction and demonstration/exercise 4.1 Stock assessment: population modelling and genetic inputs (**EJ**) ~ 1.15 h
10.30-11.00	Break		Break	10.30	Break
11.00-13.00	PART 1: INTRODUCTION TO FISHERIES AND AQUACULTURE GENETICS 1.1 Aquatic genetic resource management (**GC**) ~ 20 min 1.2 Governance and policy drivers (**JM**) ~ 20 min 1.3 Overview of genetic/genomic approaches: from proteins to genomes (**EN**) ~ 60 min 1.4 What can genetics/genomics do for you in fisheries/aquaculture? (interactive session) (**SH**) ~ 20 min		2.8 Introduction to quantitative genetics (**EN**) ~ 30 min 2. 9 Principles and applications to aquaculture (**EN,** SH) ~ 30 min 2.10 Break out Groups: exercise (e.g. selection response; parentage assignment) (**SH**,EN) ~ 1.0 h	11.00	4.2 Designing Integrated Management Plans to address a range of fisheries scenarios – Particpant Group work (**EJ**) ~ 1.15h 4.3 Plenary session : From individuals to ecosystem-based management: exploring interactions across biological levels (**GRC**) – 45 MINS
13.00-14.00	Lunch	13.00	Lunch	13.00	Lunch

14.00-16.00	PART 2: INTRODUCTORY PRINCIPLES 2.1 Background principles of population genetics (**EN**) ~ 30 min 2.2 From genetics to genomics (**GC** + SH) ~ 30 min 2.3 Stock structure and dynamics (**JM** + EJ) ~ 30 min 2.4 Genomic stock structure identification (**GRC**) – 30 min	14.00	PART 3: RECENT ADVANCES 3.1 Application of environmental DNA for fisheries (**EN**) ~ 25 min 3.2 Close kin mark recapture methods and population abundance estimates (**JM**) ~ 25 min 3.3 Traceability of fish and fish products (**GC**) ~ 10 min 3.4 Genetic tools for risk assessment: impact of aquaculture on native fish (**JM**) ~ 15mins 3.5 DATA ANALYSIS 2: Population assignment and traceability (**RC**) ~ 45 min	14.00 15.40	PART 5: UPTAKE AND POLICY 5.1 Policy recommendations from genetic data: how do we promote uptake and implementation?: Plenary discussion (**JM** + others) ~ 1.40h 5.2 Guest presentation: FAO – Details to be confirmed ~ 20 min
16.00-16.30	Break	16.00	Break		Break
16.30-18.00	2.5 Break out Groups: Laptop uploads etc – links to be distributed in advance by Rita Castilho (**RC** + SH) 2.6 Introduction to practical exercises (**SH** + EN, RC)	16.30 17.15 17.30	3.5 DATA ANALYSIS 2: (continued) ~ 15 min 3.6 PRACTICAL DEMONSTRATION: Rapid species ID diagnostics (**SH**) Part 1 ~ 40 min 3.7 Genetics for monitoring control and enforcement (**JM**) ~ 40 min	16.30	PART 6: COURSE SUMMARY/FEEDBACK/CONCLUSIONS (**SH**) Including: • Questions and clarification on material covered • Brief discussion on additional topics • Criteria for designing genetic/genomic studies • Informal feedback on course content and deliver (formal, individual course feedback is coordinated by ICES) • Other?
18.15	COACH RETURNS TO CENTRAL FARO – FREE TIME	18.15 20.00	COACH RETURNS TO CENTRAL FARO - COURSE DINNER (Details to be confirmed)	18.15	COACH RETURNS TO CENTRAL FARO AND END OF COURSE

COURSE INSTRUCTORS: Gary Carvalho (GC); Sarah Helyar (SH); Ernesto Jardim (EJ); Jann Martinsohn (JM); Einar Nielsen (EN)
LOCAL SCIENTIFIC ORGANISER: Rita Castilho (RC). Unless otherwise indicated, the approximate duration of each presentation **includes** time for questions/discussion. **INITIALS IN BOLD = Session coordinator.**

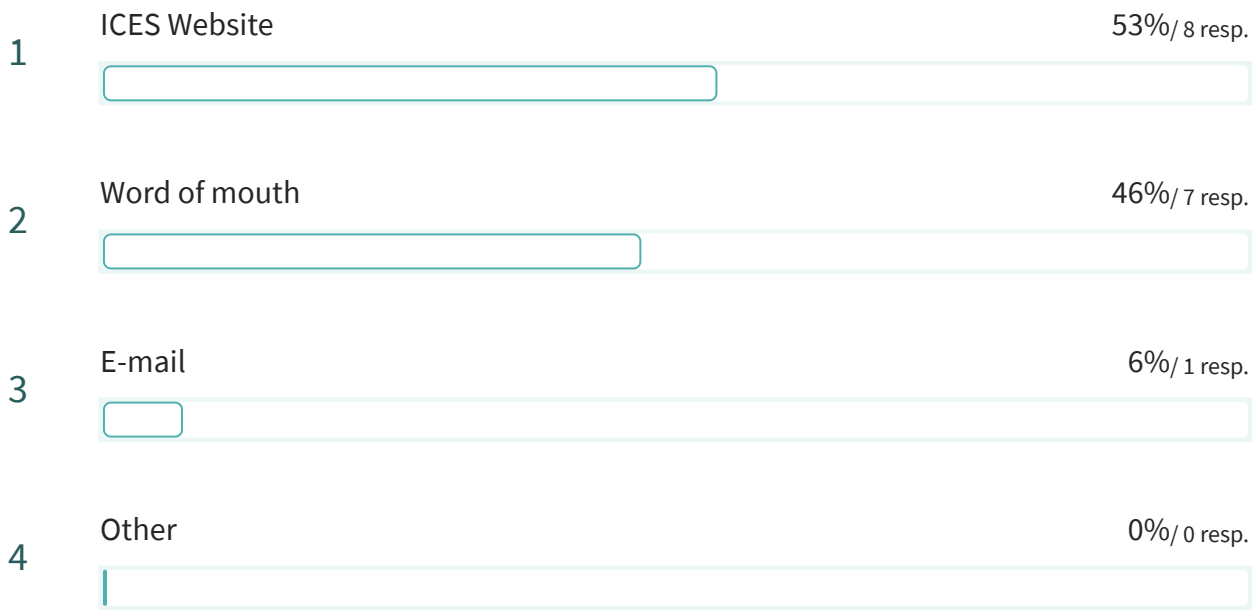
Annex 3: Results of the survey

ICES Training survey Genetics in support of fisheries and aquaculture management

15 responses

How did you hear about this course?

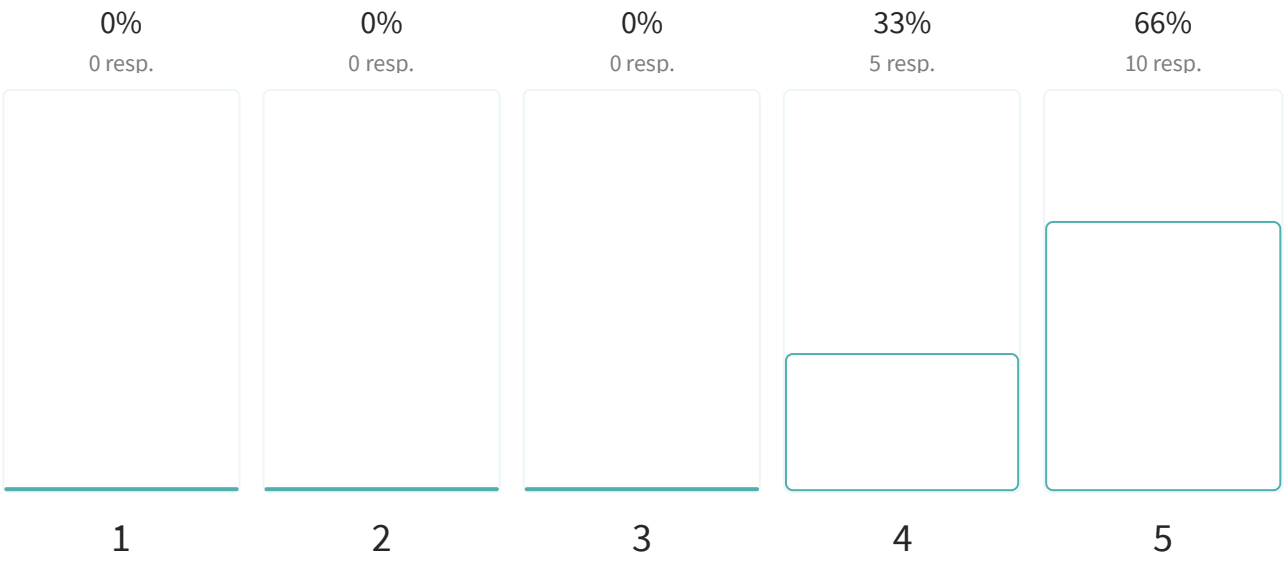
15 out of 15 answered



Did the Training course meet your expectations?

15 out of 15 answered

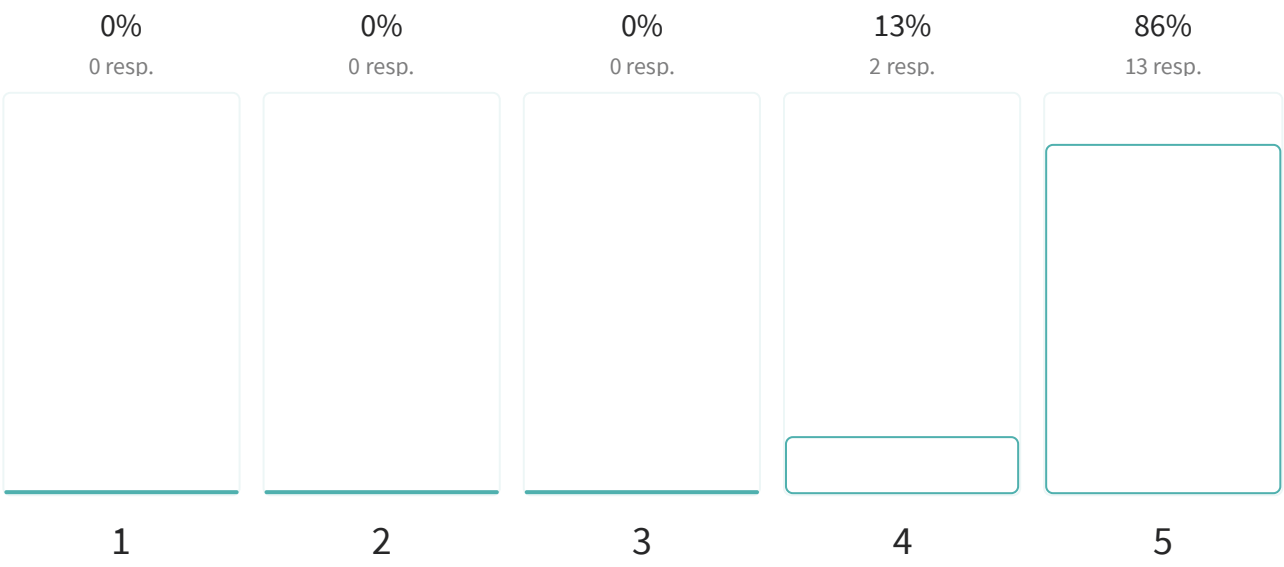
★ 4.7 Average rating



Was the level of instruction appropriate?

15 out of 15 answered

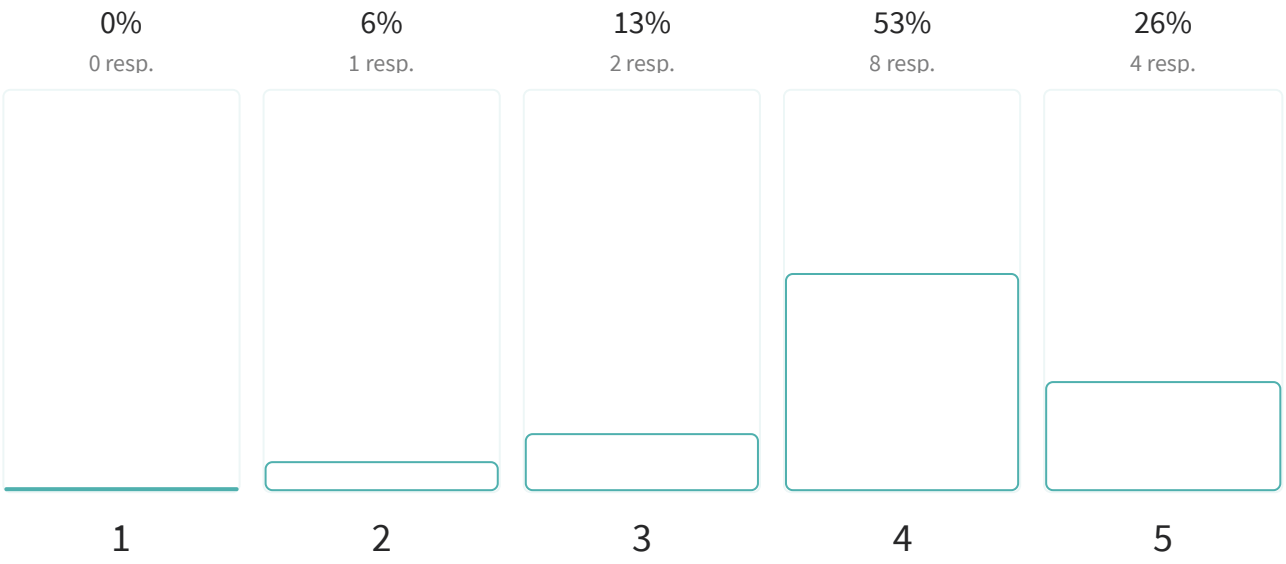
★ 4.9 Average rating



How would you rate the hands-on practical data analyses sessions?

15 out of 15 answered

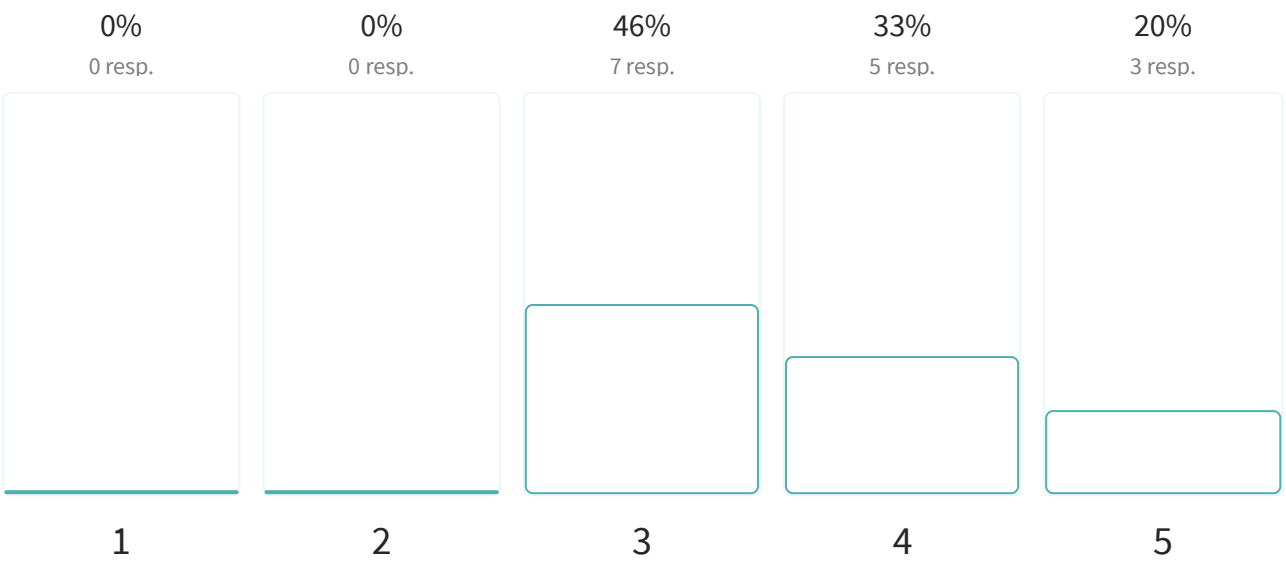
★ 4.0 Average rating



Was the length of the training course appropriate?

15 out of 15 answered

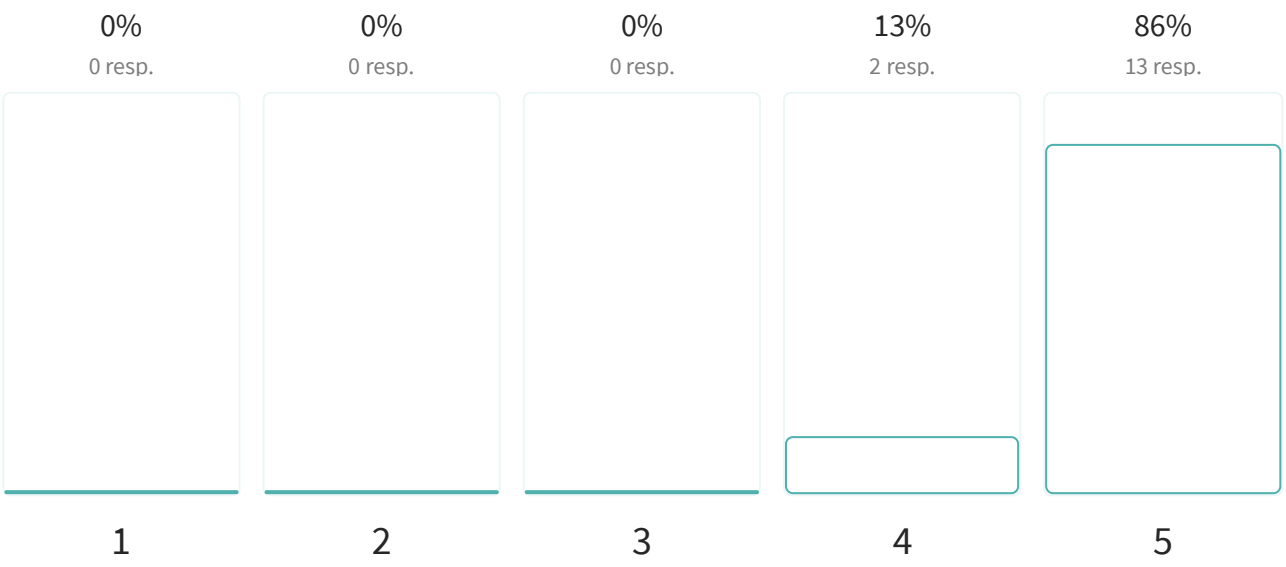
★ 3.7 Average rating



How would you rate the opportunities for interactions with course instructors?

15 out of 15 answered

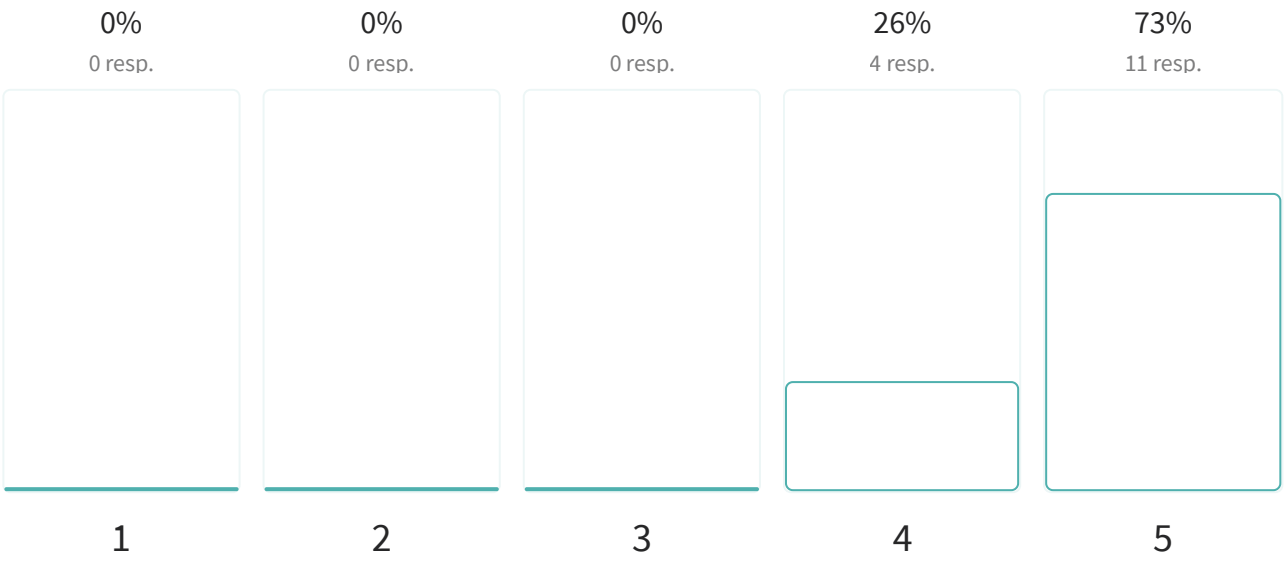
★ 4.9 Average rating



How would you rate the opportunities for interactions with other participants?

15 out of 15 answered

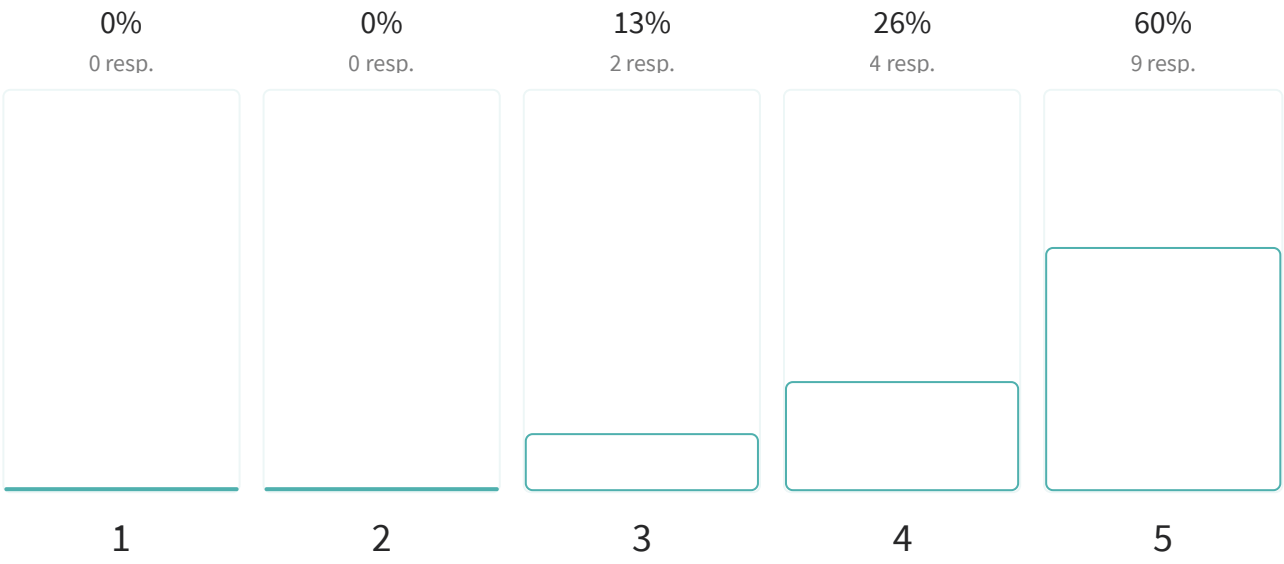
★ 4.7 Average rating



The working documents were presented in a way that facilitated learning.

15 out of 15 answered

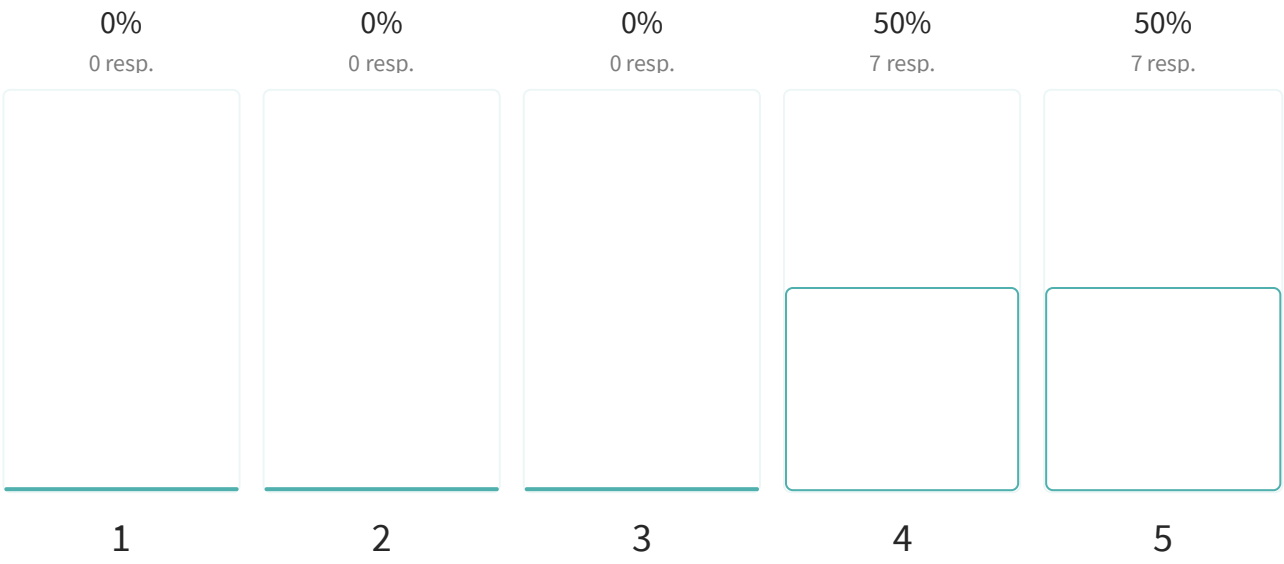
★ 4.5 Average rating



How would you rate the quality of online resources for the course?

14 out of 15 answered

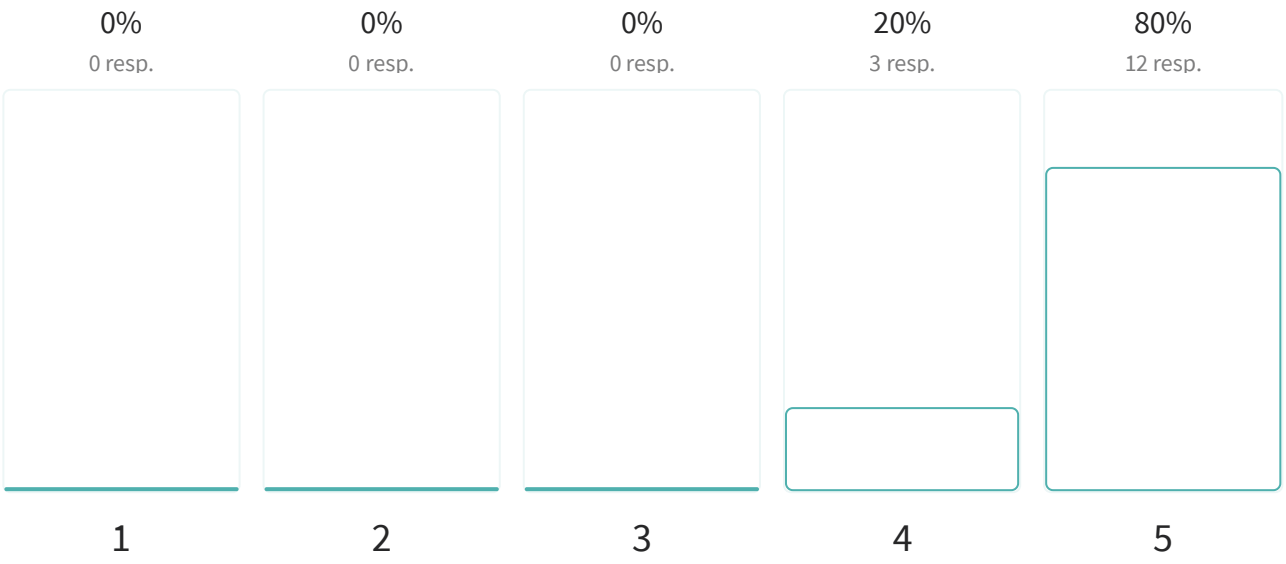
★ 4.5 Average rating



How would you rate the quality of the teaching?

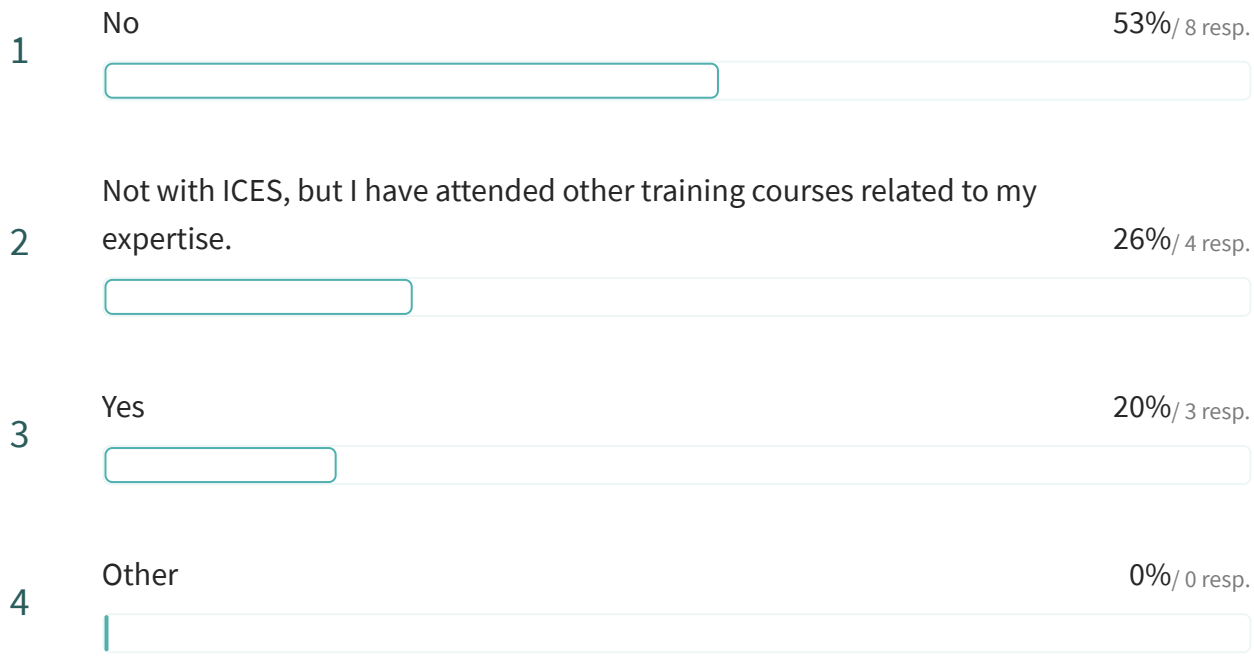
15 out of 15 answered

★ 4.8 Average rating



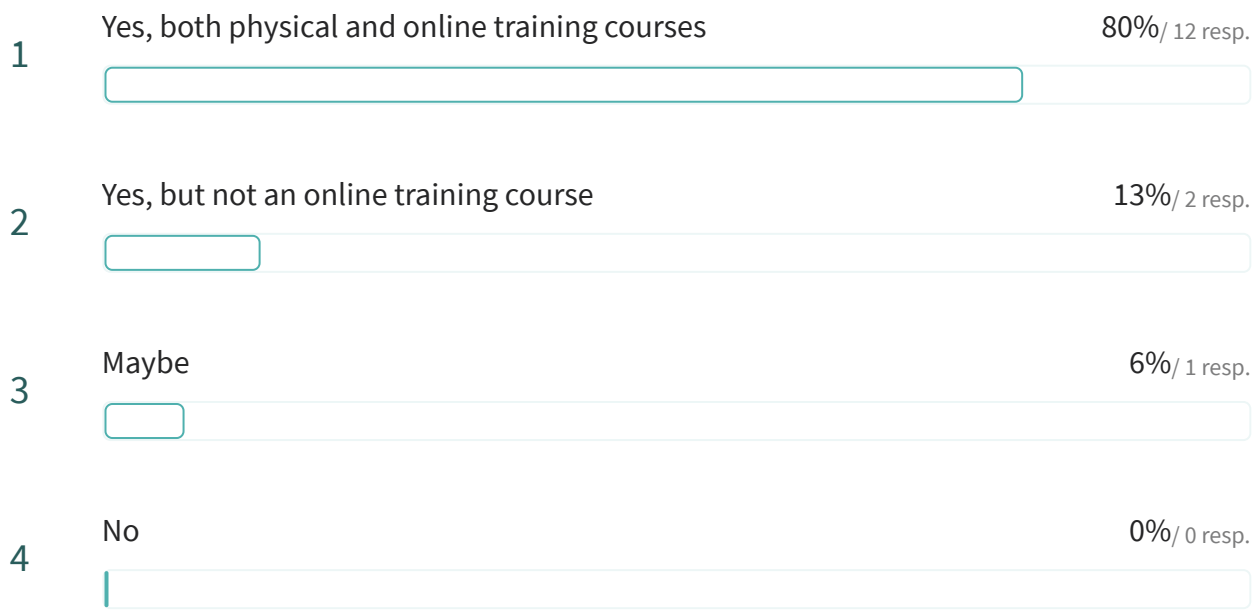
Have you taken any other ICES training courses?

15 out of 15 answered



Would you be interested in another training course within ICES?

15 out of 15 answered



Do you feel that you have benefited from networking opportunities on the course?

15 out of 15 answered