

Training Course on Introduction to Stock Assessment

ICES TRAINING COURSE REPORT



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1 Summary

The tenth ICES Introduction to Stock Assessment course was held at ICES Headquarters in Copenhagen, during 21-25 October 2019. The course, led by Coby Needle (Marine Scotland Science), Colin Millar, David Miller and Arni Magnussen (all from ICES Secretariat), was aimed at new stock assessment scientists just starting in this role and other quantitative scientists such as PhD students. As in previous years, it also attracted participants who were interested in learning about the background to and the basis of the fish stock advice that ICES produces each year. Additional ICES presentations were provided by Neil Holdsworth, Anne Cooper, Anna Davies and Julie Kellner, and the welcome provided by ICES staff was very much appreciated (as were the excellent teaching facilities).

The 22 participants came from around the world, including visitors from England, Spain, Greenland, Northern Ireland, Ireland, the Netherlands, Faroes, New Zealand, Norway, Chile, and France; and represented government and research institutes, universities, private companies and other organisations, and NGOs.

The course covered key topics such as the data used for assessments, fitting models to data, biological production, virtual population analysis, statistical catch-at-age models, yield-per-recruit, and maximum sustainable yield. ICES staff also gave talks on the ICES advice process (including overviews of two extant advice sheets), ICES data provision, and the ICES approach to providing advice for data-limited stocks. As well as presentations covering these topics, participants were led through practical applications in both Excel and R.



Participants and instructors for the 2019 ICES Introduction to Stock Assessment (TCSAI) training course, at ICES Headquarters, Copenhagen. The course instructors included Coby Needle of Marine Scotland Science in Aberdeen, Scotland (far right) and Arni Magnussen of ICES (second from left) – Colin Millar and David Miller (also of ICES) were not available for the photo.

2 Background and context

ICES provides advice on fishing opportunities for more than 200 stocks in European waters. It does so through the work of stock assessment scientists provided by research and government institutes, as well as universities, based mostly in the countries participating in fisheries for these stocks. In order to maintain the quality and consistency of assessments and subsequent advice, it is important to train new stock assessment scientists to ensure that they will be able to contribute in full to this process. In addition, quantitative fisheries scientists and ecosystem modellers can also benefit from an understanding of the principles and methods underlying stock assessments. This course is intended to provide the requisite introductory training for both of these groups.

Previous versions of this course have attempted to cover the requirements of both stock assessment (and other quantitative) scientists, and a wide range of fisheries managers, policy officers and other interested parties. This has proven to be a difficult balance to achieve, and the course advert for 2019 was aimed more directly at the former group. Despite this, a significant proportion of this year's course were not quantitative scientists, and while they managed to complete the exercises, comments indicate they were looking for more information and examples on the ICES advice and processes. There is a considerable external audience for the ICES advice, and it is equally important that these advice recipients are able to understand and make best use of the advice. The balance between the two groups remains a difficult one to find.

2.1 Objectives

The general objective of the course was to train stock assessment (and other quantitative) scientists and fisheries advisors in basic population dynamics and fisheries stock assessment. The course was intended to not only present the theoretical elements but also put theory into practice through case studies and hands-on exercises (principally in Excel, but with additional exercises in R).

Specific objectives were:

- understanding the role of stock assessment in fishery science and advice;
- familiarity with conventional stock assessment models;
- experience in basic model building and parameter estimation.

By the end of the course, the participants were to:

- be aware of single species assessment methods as applied to North Atlantic fisheries;
- understand the data-collection needs for different assessment methods;
- be familiar with indicators and reference points, both biological and economic, as tools in fishery management;
- develop knowledge of population and fishery processes by using simulation models to develop scientific advice as if for fisheries managers.

2.2 Level

The course provided a conceptual understanding, supported by quantitative applications that were designed to illustrate model properties. Advanced topics and programming skills were introduced in preparation for more advanced ICES courses or to approach the same topics through self-learning. Familiarity with Excel was a pre-requisite, while knowledge of the R programming environment was recommended.

3 Course Programme, Product, Deliverance and Instructions

3.1 Programme

The course featured a very full programme over the 5 days. Although not all of the intended topics could be covered in the time available, the presentations and exercises for all of the material were made available to the participants, and some one-to-one discussions towards the end of the week helped to fill in some of the gaps for the attendees.

The topics covered in chronological order were as follows:

1. Introduction.
2. Model fitting – concepts of mathematical and statistical modelling, and simple stock-recruitment model fitting with both Excel and R.
3. The ICES advisory process and ICES advice sheets.
4. Biological production and sustainable yield – essential concepts in stock assessment science such as exponential decay, fishing mortality and the catch equation.
5. ICES data collation and provision – what is available to stock assessment scientists and others.
6. Virtual Population Analysis (VPA) – cohort analysis using catch data with fixed final-year F .
7. Calibrated VPA – cohort analysis with a mean F final-year assumption.
8. Statistical catch-at-age (SCAA) – separable model using both catches and survey data.
9. The ICES approaches for data-limited stocks.
10. Biomass dynamics models – a simpler production model using catch yield and a biomass estimate from a survey.
11. Dynamic pool models – yield-per-recruit (YPR).
12. Age-based estimation of maximum sustainable yield (MSY).
13. Conclusion

The topics that couldn't be covered due to lack of time were simple demographic models (catch curves), simple size-based methods and integrated stock assessment models.

Throughout the course, the majority of case studies and exercises used data from the North Sea cod fishery and surveys. This meant that participants could compare and contrast stock perceptions from three different assessment models (VPA, SCAA and a biological production model), as well as fishery reference points from three different approaches (YPR, age-based MSY and biomass-based MSY).

There was also time devoted to discussion of issues raised, both one-to-one and in a group context, and this proved to be a key part of the course. A number of participants had questions they had "always wanted to ask ICES" about the advice and how it is generated, and this time gave them ample opportunity to do so.

3.2 Course products

The course materials consisted of 13 Powerpoint presentations, 7 Excel spreadsheet templates, and access to a GitHub repository containing sample R code for the same 7 applications as were covered in the Excel templates. Interested participants were also provided with additional Powerpoint slides and a spreadsheet template for length-based analyses, as these couldn't be covered during the week. Finally, Coby Needle made materials available from three of his previous University of Aberdeen MSc courses (2014, 2015 and 2018), including presentations, coursework notes and manuals, sample data, spreadsheet templates and R scripts. These were distributed through the course Sharepoint site.

Suggested further reading included:

Stock assessment

- Haddon, M. (2001). *Modelling and Quantitative Methods in Fisheries*. CRC Press.
- Quinn, T. J. II, and R. B. Deriso. (1999). *Quantitative Fish Dynamics*. Oxford University Press, New York.
- Hilborn, R. and C.J. Walters. (1992). *Quantitative Fisheries Stock Assessment: Choice, Dynamics, and Uncertainty*. Chapman and Hall.
- Ogle, D. H. (2016) *Introductory Fisheries Analyses with R*. CRC Press

Fisheries

- Jennings, S. Kaiser, M. J. and Reynolds, J. D. (2008). *Marine Fisheries Ecology*. Wiley-Blackwell.

Statistics

- Hilborn, R. & Mangel, M. (1997) *The Ecological Detective: Confronting Models With Data*. Princeton University Press

Programming

- Braun, W. J. and Murdoch, D. J. (2016). *A First Course in Statistical Programming in R* (2nd edition). Cambridge University Press.
- Zuur, A. Ieno, E. N. and Meesters, E. (2009) *A Beginner's Guide to R*. Springer.

Software

- FLR (Fisheries Library in R): flr-project.org
- NFT (NOAA Fisheries Toolbox): nft.nefsc.noaa.gov
- SAM (Stock Assessment Model): www.stockassessment.org

3.3 Deliverables

The specific learning objectives were for participants to:

- be aware of single species assessment methods as applied to North Atlantic fisheries;
- understand the data-collection needs for different assessment methods;
- be familiar with indicators and reference points, both biological and economic, as tools in fishery management;

develop knowledge of population and fishery processes by using simulation models to develop scientific advice as if for managers.

3.4 Course instructors

Dr Coby Needle, Marine Scotland Science

Lead instructor

Dr Coby Needle is the Chief Fisheries Advisor for Scotland, and Head of the Fisheries Assessment and Advice Programme at Marine Scotland Science in Aberdeen. He has nearly 25 years' experience in ICES fisheries stock assessments, including periods as chair of the WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak and the Assessment Methods WG, and he is the ongoing developer of the SURBAR survey-based assessment model. He has taught courses in stock assessment in several countries around the world, and is an Honorary Lecturer at the University of Aberdeen where he teaches at the postgraduate level.

Arni Magnusson, ICES

Practical exercises and R demonstrations

Dr Arni Magnusson is a Data and Assessment Professional Officer at the ICES Secretariat. His publications and software packages focus on stock assessment methods and statistical modelling in general. Before joining the Secretariat, he worked on stock assessments in the Pacific Northwest, New Zealand, and Iceland. He is the current chair of the ICES Methods Working Group and has taught courses in stock assessment and statistical modelling in several universities, along with ICES training courses.

Colin Millar, ICES

Practical exercises and R demonstrations

Dr Colin Millar is a Data and Professional Officer at the ICES Secretariat, he has nearly 20 years' experience working with fisheries data, as a stock assessor and as an applied statistician in marine and freshwater fisheries. He is the current developer of several R packages for working with marine and freshwater data, and the co-developer of a stock assessment model (a4a) currently used for some Mediterranean stock assessments.

David Miller, ICES

Practical exercises and advice context

Dr David Miller is a Professional Officer in the Advisory Department at the ICES Secretariat. He has worked at international marine science research institutes in South Africa, Canada and the Netherlands. He has extensive experience with quantitative fish stock assessment (demersal, pelagic, and shellfish stocks) with a focus on analyses for practical fisheries management (including management strategy evaluation) and communication of fisheries management advice to relevant stakeholders

3.5 Recommendations

The participants' comments in the course survey (Annex 3) were broadly very positive, with the bulk of any negative comments asking for more information where possible (and time permitting). In the opinion of the instructors, the changes made to the course since 2018, in terms of pacing and the use of a single stock case-study, have helped to improve the learning experience for the participants, but there remains several issues that it would be helpful to address for the planned 2020 course. These include:

- Fitting stock-recruit models serves as a gentle introduction to model fitting, but it also uses the output from stock-assessment models that have not yet been covered at that stage of the course. It might be better to start with simple biological production models, before moving on to age-based VPA and SCAA. Once those are complete, stock-recruit

and yield-per-recruit models could be fitted to enable estimate of MSY and other reference points, and the participants could explore how these change with different stock-assessment models (and the consequent changes in perception of stock status).

- It would be straightforward to include a short exercise on catch-curve analysis, as an intermediary step between biological production models and age-based assessment approaches.
- It would be beneficial to be able to include a module on length-based assessments, with perhaps a simple cohort-based distribution approach, but it seems unlikely that there would be time within the 5 days of the course to achieve this. It may only be possible to do so by missing one or more of the ICES presentations, which themselves provide excellent background.
- Joining instructions for participants need to be clear that they will need Excel with Solver, and R with the possibility to install libraries and packages. These requirements caused problems for some of the class.
- The SCAA practical relies on weights, maturity and natural mortality from the MSY practical, which on reflection is the wrong way round. This could be avoided by including the calculations for these quantities on the SCAA sheet instead.
- There could be an additional short module on how to access survey data from the DATRAS database, and then these could feed directly into the catch-curve analysis example.

Annex 1: List of participants

Name	Institute
Alice Moore	Marine Conservation Society Overross House - Fisheries and Aquaculture Team
Ana Colmenero	Institute of Marine Sciences - Renewable Marine Resources Department
Anders Bjørn Larsen	Government of Greenland, Ministry of Fisheries, Hunting and Agriculture
Carrie McMinn	Agri-food and Biosciences Institute, Fisheries and Aquatic Ecosystems Branch Newforge Lane
Cesar Santana	National University of Ireland Ryan Institute
Charlotte Coombes	Marine Conservation Society Overross House - Fisheries and Aquaculture Team
Eleanor MacLeod	Centre for Environment, Fisheries and Aquaculture Science
Esther Beukhof	Wageningen Marine Research
Fróði Skúvadal	Faroe Marine Research Institute
Gretchen Skea	Fisheries New Zealand - Fisheries Science and Information
Hannipoula Olsen	Havstovan Faroe Marine Research Institute
Jessica Tengvall	University of Bergen
Johanna Fall	Havforskningsinstituttet
Johnathan Ball	Centre for Environment, Fisheries and Aquaculture Science
Jose Montero	Pontificia Universidad Catolica de Chile Center of Applied Ecology and Sustainability
Julio Agujetas	Marine Stewardship Council Spain & Portugal Office
Katherine Morris	Customised Assurance - Fisheries Department Lloyd's Register
Mariona Garrigo Panisello	Institute of Marine Sciences
Michelle Hackett	Department for the Environment, Food and Rural Affairs, Marine & Fisheries Directorate
Morgana Tagliarolo	IFREMER
Norbert Billet	IFREMER
Tarek Hattab	IFREMER

Annex 2: Agenda

The agenda for the course changed during the week, according to the interests of the participants and the restrictions of time. The final schedule was as follows:

Monday 21st October

- Introduction to ICES and course logistics (Anna Davies / Julie Kellner)
- Introduction (Coby Needle)
- Objectives of stock assessment (Coby Needle)
- Data for stock assessment (Coby Needle)
- Fitting models to data (Coby Needle)
- Assignment: stock-recruit models (Excel: Coby Needle, R: Colin Millar and Arni Magnussen)
- Evening icebreaker

Tuesday 22nd October

- ICES fisheries advice – an overview (David Miller)
- Biological production and sustainable yield (Coby Needle)
- Assignment: tracking a cohort through time and recruitment variability (Excel: Coby Needle, R: Arni Magnussen)

Wednesday 23rd October

- Data considerations (Neil Holdsworth)
- Virtual Population Analysis and Calibrated VPA (Coby Needle)
- Assignment: VPA (Excel: Coby Needle, R: Arni Magnussen)
- Dynamic pool models (Coby Needle)
- Assignment: Yield-per-recruit models (Excel: Coby Needle, R: Arni Magnussen)

Thursday 24th October

- The ICES approach for category 3-4 stocks (Anne Cooper)
- Statistical catch-at-age models (Coby Needle)
- Assignment: SCAA (Excel: Coby Needle, R: Arni Magnussen)
- Course dinner

Friday 25th October

- Biomass dynamics models (Coby Needle)
- Assignment: fitting a biomass dynamics model (Excel: Coby Needle, R: Arni Magnussen)
- Age-based Maximum Sustainable Yield (Coby Needle)
- Standard graph data (David Miller)
- Transparent Assessment Framework (Arni Magnussen)
- Conclusion



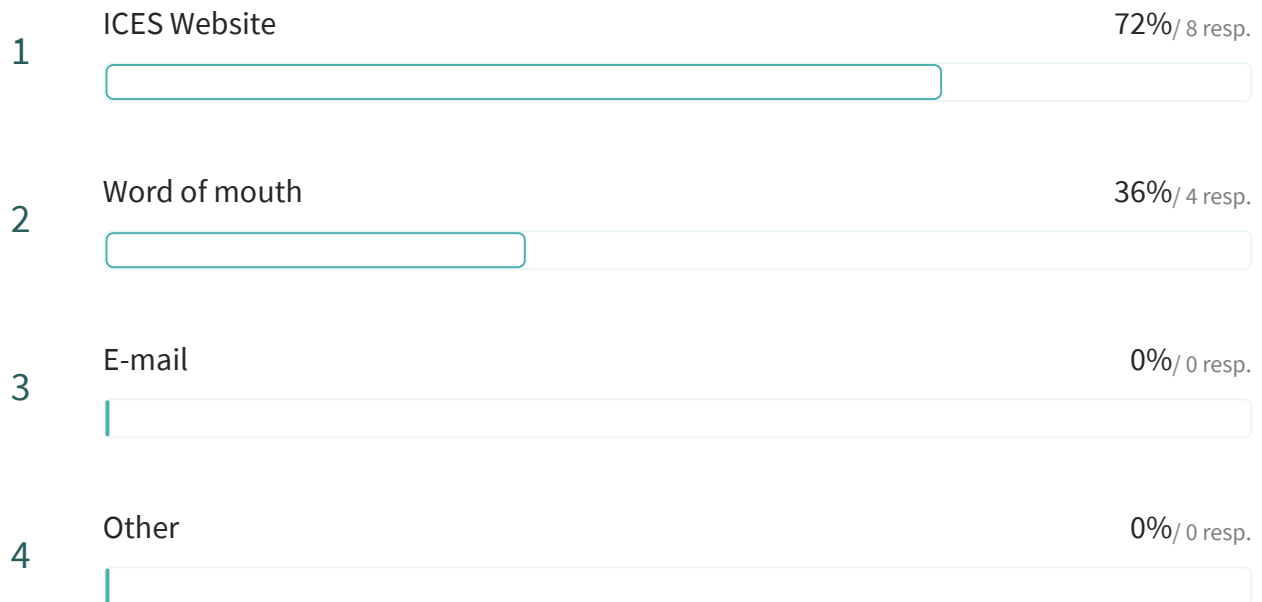
Participants hard at work in the Atlantic Room, ICES.

Annex 3: Results of the survey

12 responses

How did you hear about this course?

11 out of 12 answered

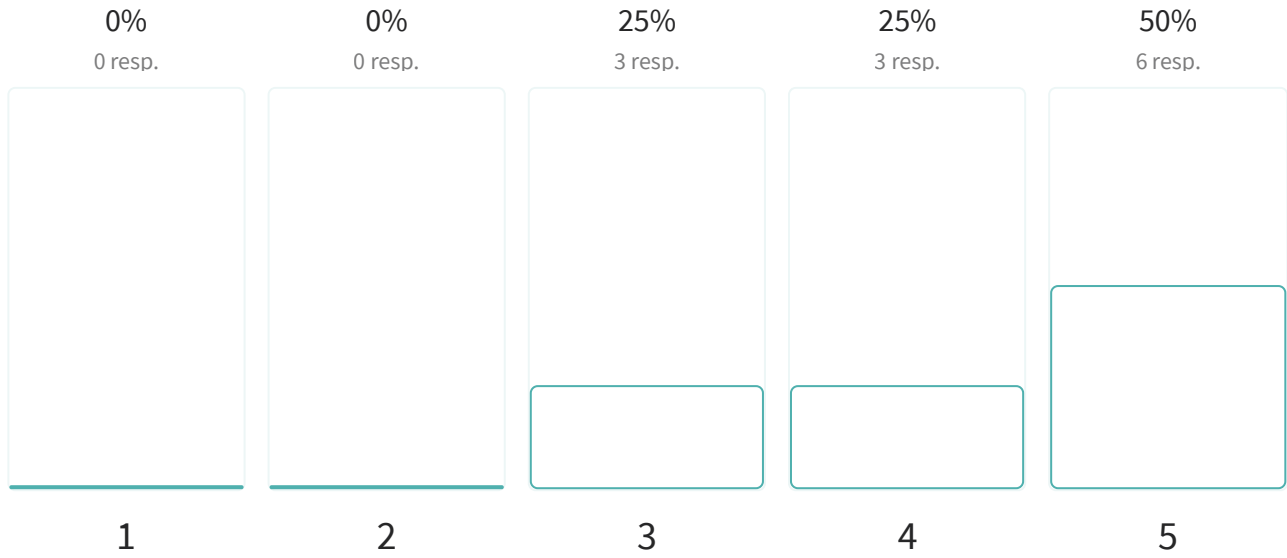


Course content

Did the Training course meet your expectations?

12 out of 12 answered

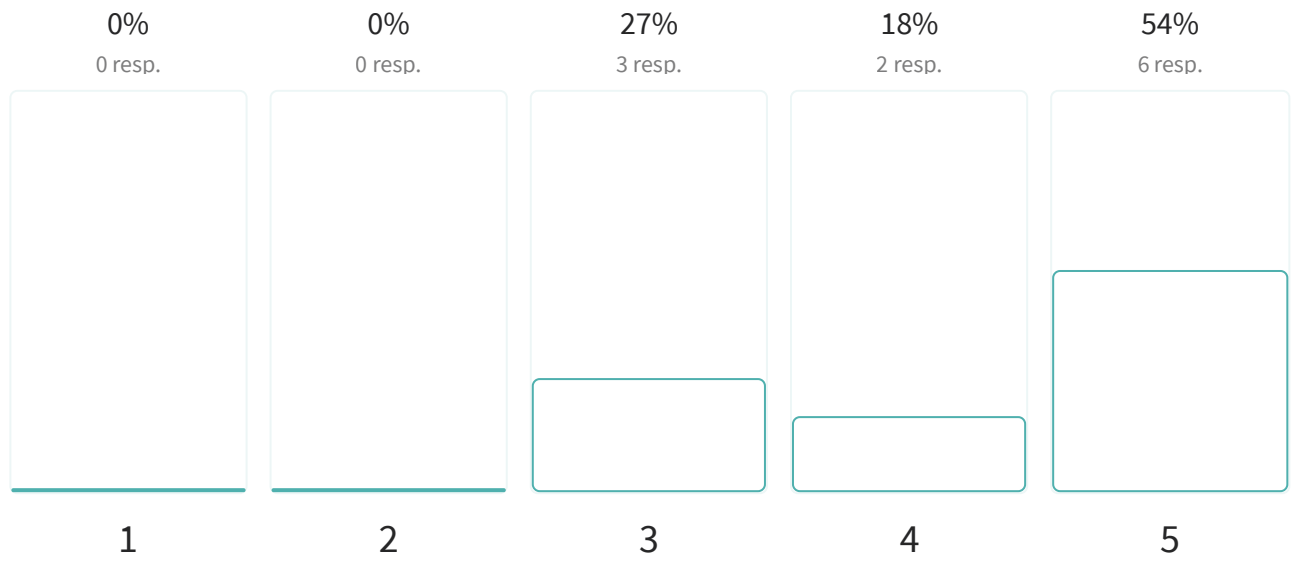
★ 4.2 Average rating



Was the level of instruction appropriate?

11 out of 12 answered

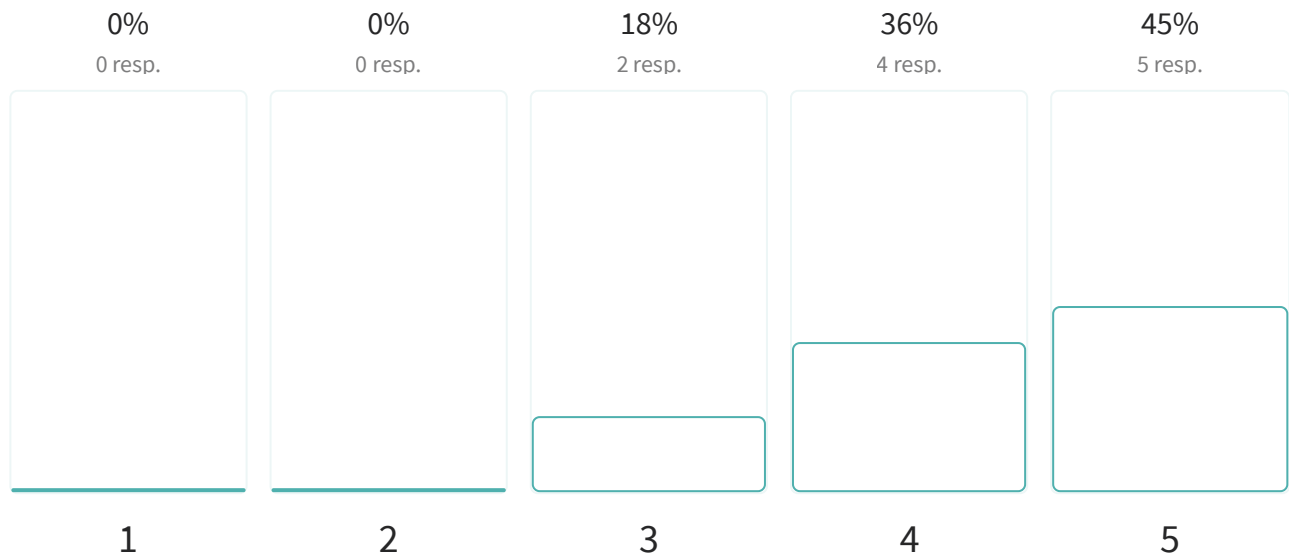
★ 4.3 Average rating



Was the length of the training course appropriate?

11 out of 12 answered

★ 4.3 Average rating

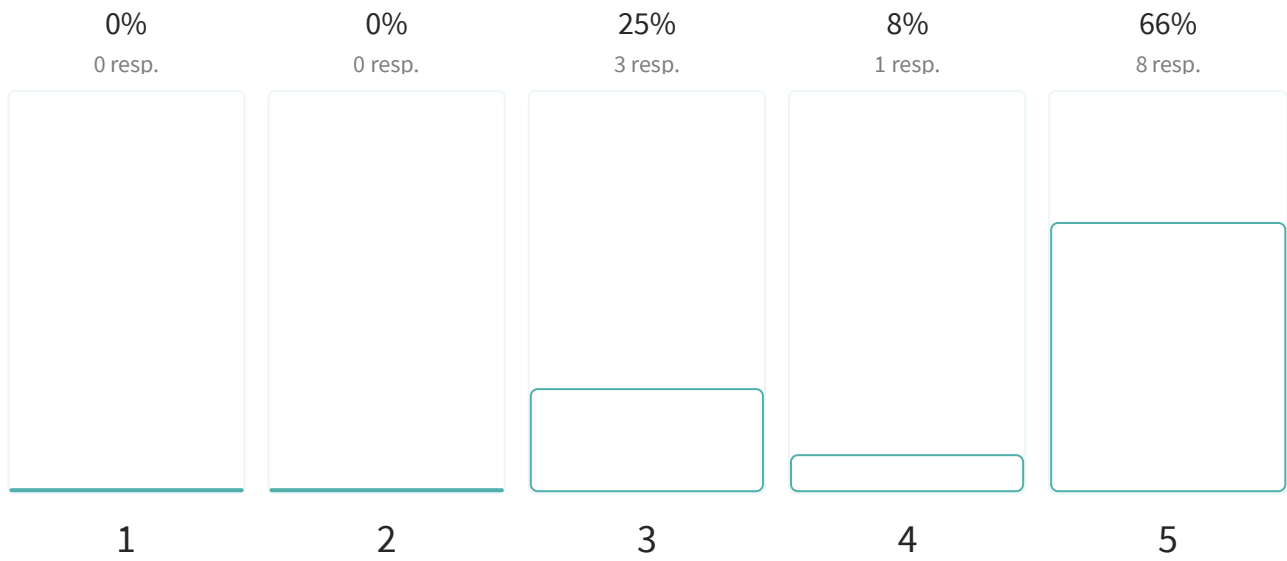


Course Organization

Inscription to the training course and communication with organizers were efficient.

12 out of 12 answered

★ 4.4 Average rating

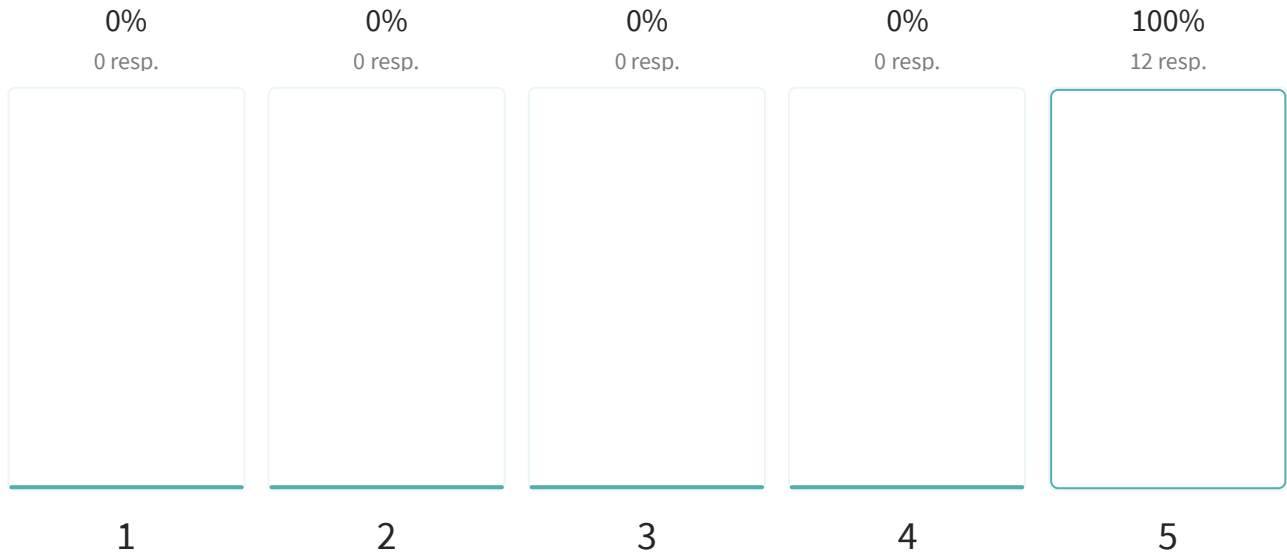


Teaching and Learning Support

The instructors were helpful, informative, and approachable.

12 out of 12 answered

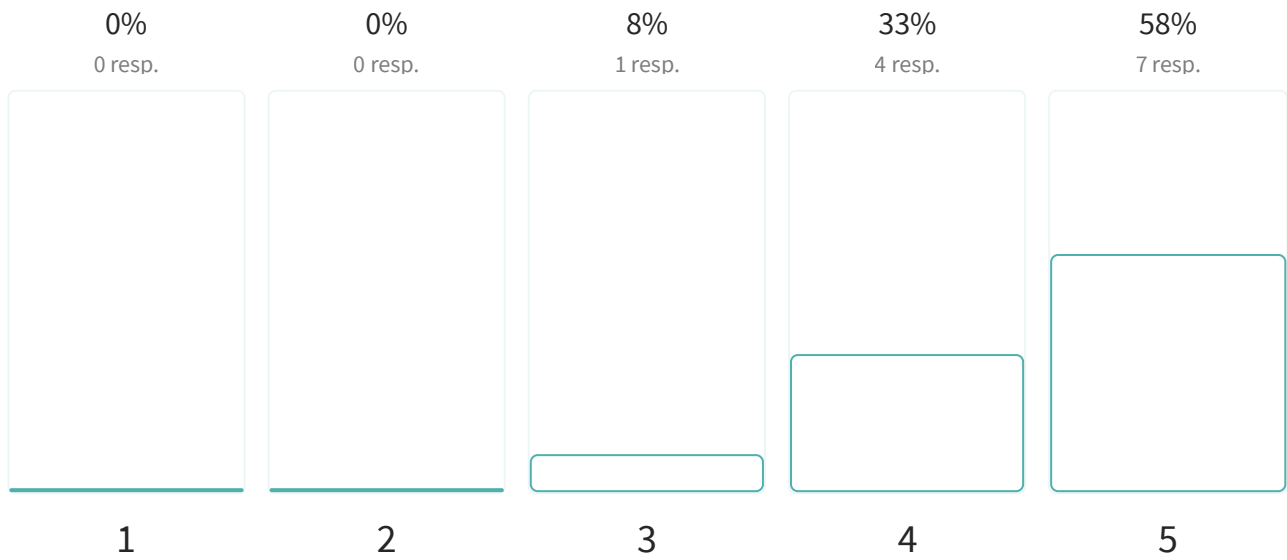
★ 5.0 Average rating



The course materials were presented in a way that facilitated learning.

12 out of 12 answered

★ 4.5 Average rating

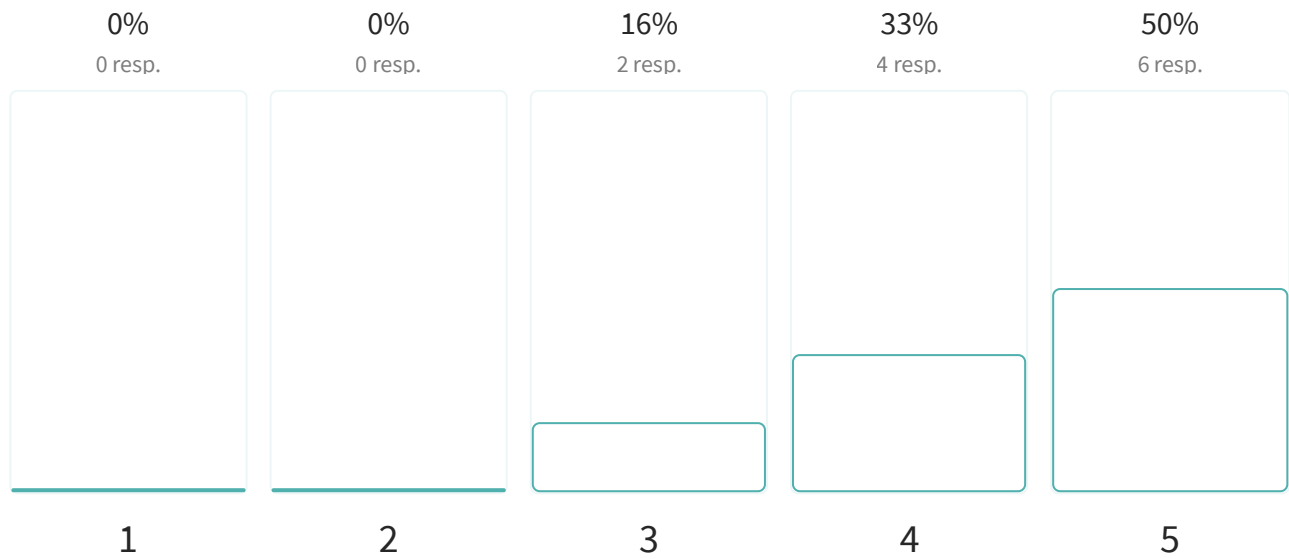


Overall Evaluation

How would you rate this training course?

12 out of 12 answered

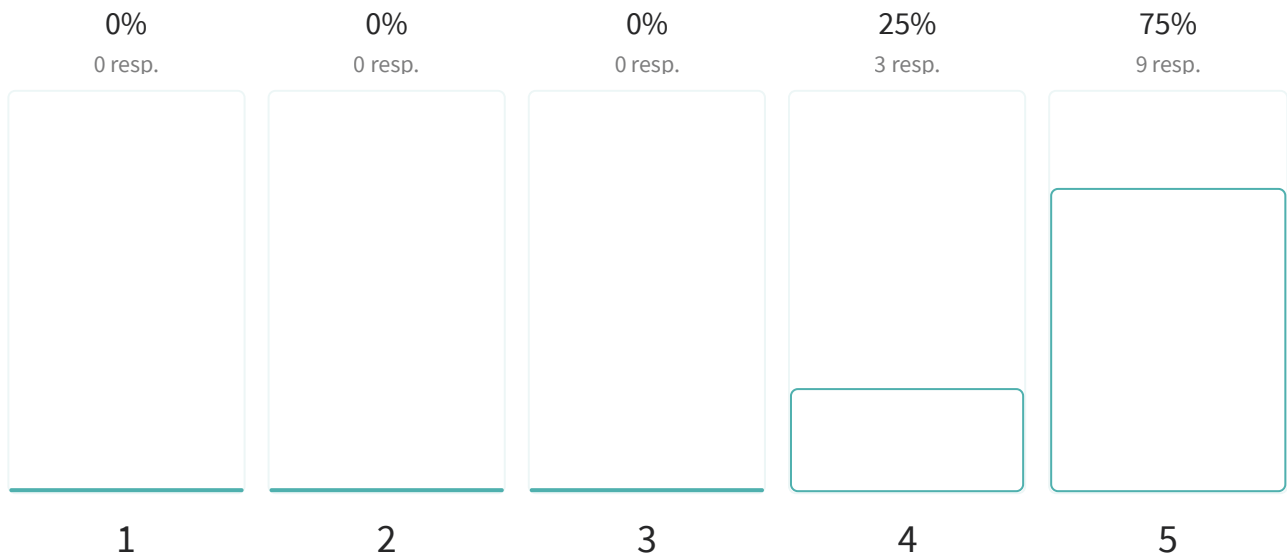
★ 4.3 Average rating



How would you rate the quality of the teaching?

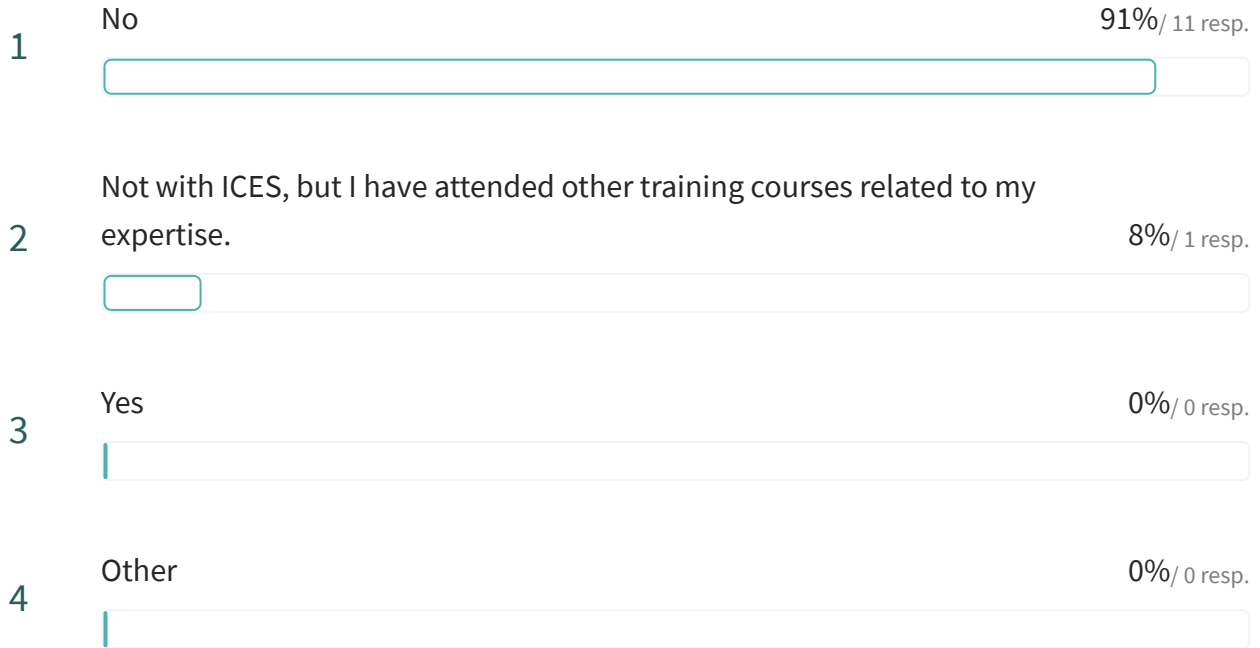
12 out of 12 answered

★ 4.8 Average rating



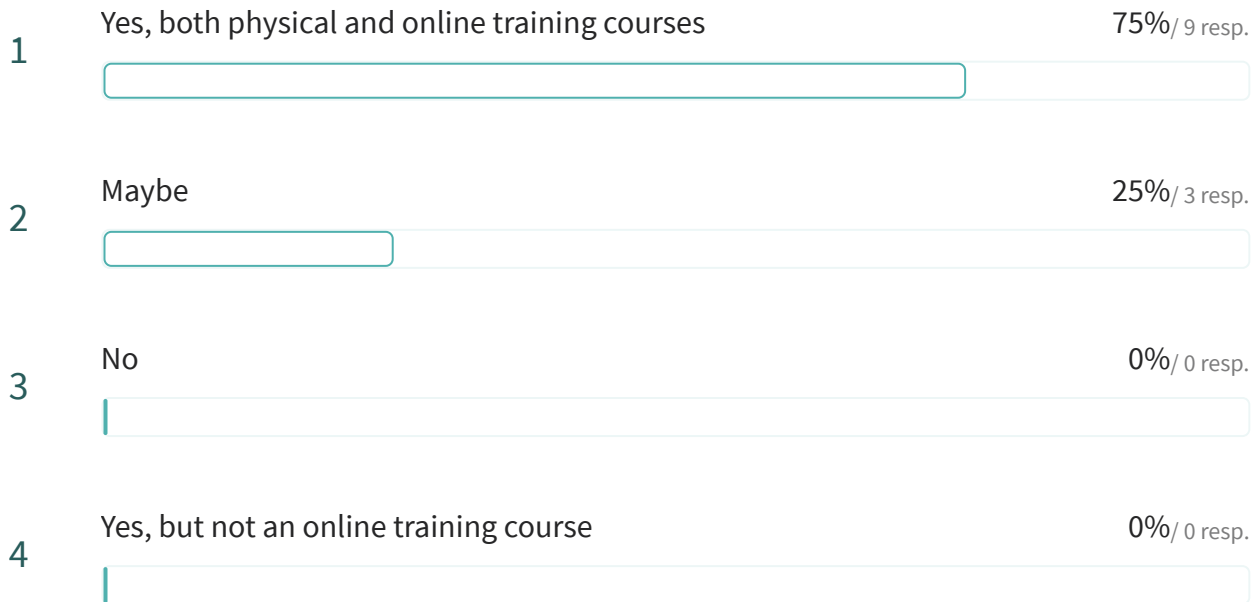
Have you taken any other ICES training courses?

12 out of 12 answered



Would you be interested in another training course within ICES?

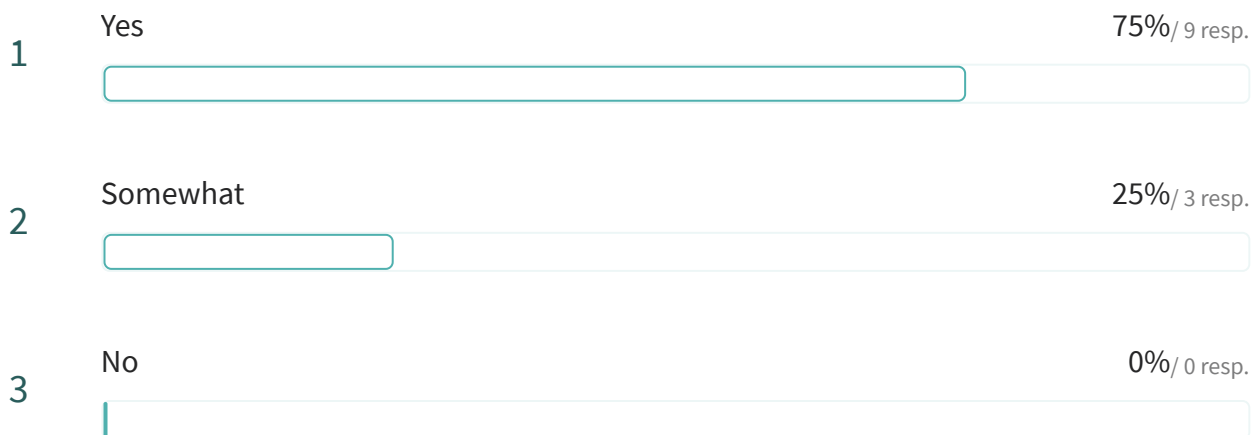
12 out of 12 answered



Social Event

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

12 out of 12 answered



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