Day 1 Session 5

Design Training - Training Design Elements

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Course roadmap

Sun 7 May
Introduction Day

Mon 8 May
Day 1
Capacity Building

Introduction
Overview of basic concepts
Case studies

Tue 9 May
Day 2
Specimen and Sequencing

Wed 10 May
Day 3
Data Tools and Pipelines

Thu 11 May
Day 4
Frameworks, Guidelines, and Decision-making

Fri 12 May
Day 5
Projects Review and Action Planning

Next steps and Beyond

Learning outcomes

- Define course design elements and pathways for pathogen genomics training
- Discuss good educational practice in learning and training design for pathogen genomics and bioinformatics
- Outline a plan for delivering a short training event to a selected audience

Session topics

This session will cover the end-to-end pathway for developing training

- Goals and objectives
- Defining target audiences
- Training needs assessment
- Training strategies
- Assessment

Defining goals, objectives and target audience

Why and how will you address the problem?

Problem identification example

- What is the problem you wish to address?
- Burden of disease spread, inadequate skills or knowledge, new policy?
- Emergence of new technologies, increased sequence generation?

Viral genomics and bioinformatics training intervention case study

Viral diseases including zoonotic infections, are a major public health burden, causing millions of deaths worldwide. Challenges faced include limited access to resources and infrastructure for timely diagnosis and surveillance. In the UK, an upsurge of influenza deaths was recorded in 2018-2019. Apart from health risks, emerging viral infections and outbreaks also pose a huge financial burden, especially in the developing countries. For example, the SARS coronavirus outbreak in 2003 caused an economic cost of US$ 60-80 billion. Over 2 billion was lost in the West African countries affected by the Ebola epidemic in 2014. Dengue is endemic in at least 100 countries worldwide with high prevalence in Asia, Africa, the Americas and the Caribbean countries. SARS-Cov-2 was devastating to health systems, economies and communities. Rapid and accurate detection using genomics technologies enables early warning of circulating variants of concern and for appropriate interventions to be implemented and minimise death risk.

Advances in research technologies are enabling access to improved detection, surveillance and management of diseases. In recent years, next generation sequencing (NGS) technologies are playing an important role in the viral identification, classification, drug resistance and treatment and surveillance. Early identification of a virus and quick analysis of its genome will aid in better treatment and help in controlling the disease spread. However, expert knowledge of viral genome sequence analysis is required. However, there is limited knowledge and expertise in the analysis and interpretation of genomics data generated from large scale sequencing. Bioinformatics skills are in high demand among researchers and clinical staff, and yet training opportunities are few and often held as once-off workshops.

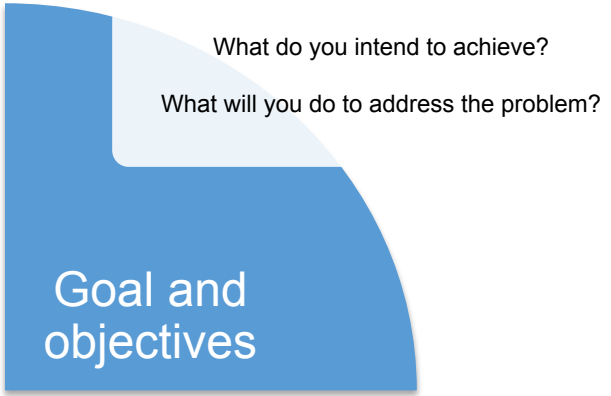
Goals and objectives of a training programme

Goal - What is the main outcome you would like to achieve as a result of the training intervention

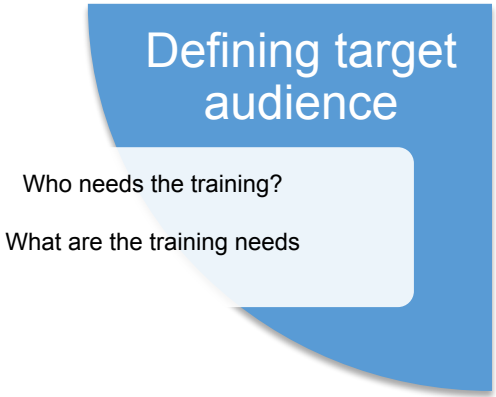
Objective - What will you do to address the problem?

Example goal: To establish capacity for analysis of genomics data for pathogen surveillance
Objectives:

- To deliver 5 training courses to early career scientists in application of bacterial pathogen genomic surveillance tools.
- To establish a network of scientists conducting surveillance of bacterial AMR.



Defining your target audience and training needs



- Specifically who needs the training and in what context or work environment? All scientists or specific specialty. What skills are needed for them to fulfill their work?
- Determine their training needs, interests, skills gaps
- Methods for conducting needs assessment
  - Quantitaive methods
  - Qualitative methods
  - Refer to existing data on training
  - Analysis and interpretation

Justification of training

- Course proposal for department
- Align with institutional or national strategies
- Funding proposal
- Defining impact - if you conducted this training what will be the impact

Contextual issues

- Format - F2F, online delivered or blended
- Short course, module, workshop
- Pre-requisites
- Administrative requirements and organisational policies
- Trainer limitations and solutions
- Infrastructure limitations
- Health and safety requirements

Defining goals and objectives

Activity 1: Goals and objectives

Based on the statement - Viral genomics and bioinformatics training intervention case study

- Outline the following
  - Summary of the problem
  - What is your proposed intervention?
  - How do you set out to address this problem
  - What is your goal
  - What is/are the objective(s) - how will your goal be achieved?

Needs assessment

Activity 2: Needs assessment

- **Read the statement and outline the following**
  - What other information do you need?
  - How will you collect it?
  - Refine your goal, objectives, target audience given the additional information from the needs assessment

Learning outcomes and competencies -

Definitions

Knowledge – domain specific expertise: foundation of facts, ideas and concepts, in-depth understanding of subject matter organised in such way to facilitate retrieval and application

Skill- ability to perform an activity or task, as a result of training and practice. Practical application of knowledge.

Attitude – behavioural aspect – ways of thinking or feeling about something that affects behaviour, such as approach or motivations towards something.

Single Competency is a set of {K,S,A} needed to successfully fulfil requirements in one area of a larger domain

Competency framework {set of Competencies for a profession, job}

Context here {use primarily in training and course designing, rather than for recruiting purposes), but also in mapping wider programmes to be able to determine missing skills

Building competency framework

Define audience/persons

|

Define competencies

|

Define KSA for each competency

|

Define level on the Blooms for each competency

More details about competency frameworks in the Handout - Virtual TtT Week 2 Guidelines and Reference materials.docx

Writing learning outcomes

REMEMBER: Recall facts or basic concepts

Define, duplicate, list, memorise, repeat, state

UNDERSTAND: Explain ideas and concepts

Classify, describe, discuss, explain, identify, locate, recognise, report, select, translate

APPLY: Use information in new situations

Execute, implement, solve, use, demonstrate, interpret, solve, sketch

ANALYSE: Draw connections among ideas

Differentiate, organise, relate, compare, contrast, distinguish, examine, experiment, question, test

EVALUATE: Justify or stand for a decision

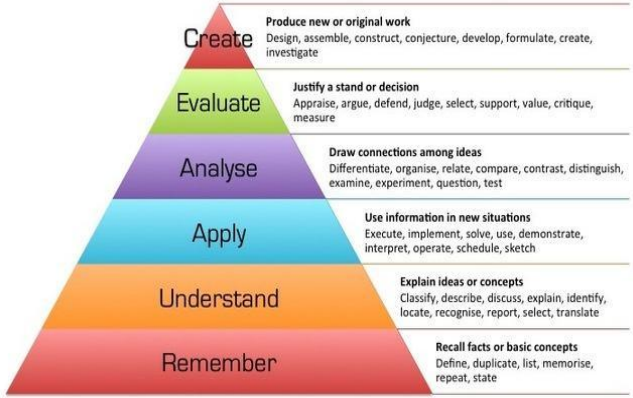
Appraise, argue, defend, judge, select, support, value, critique, measure

CREATE: Produce new or original work

Design, assemble, construct, conjecture, develop, formulate

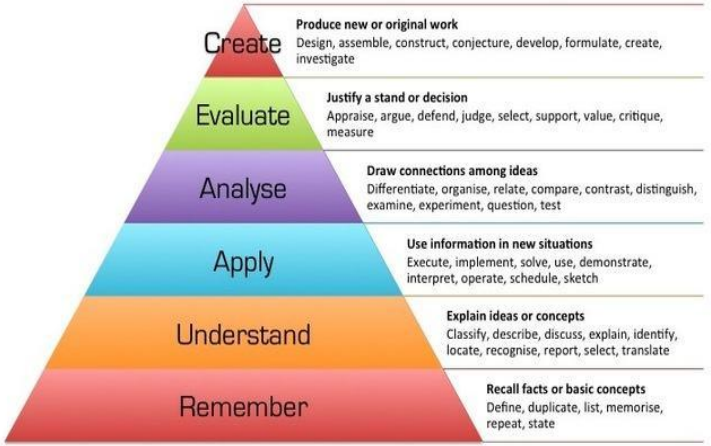
Formula for writing LOs:

Use an active verb (what participants will be able to do) + object + qualifying phrase to provide a context.



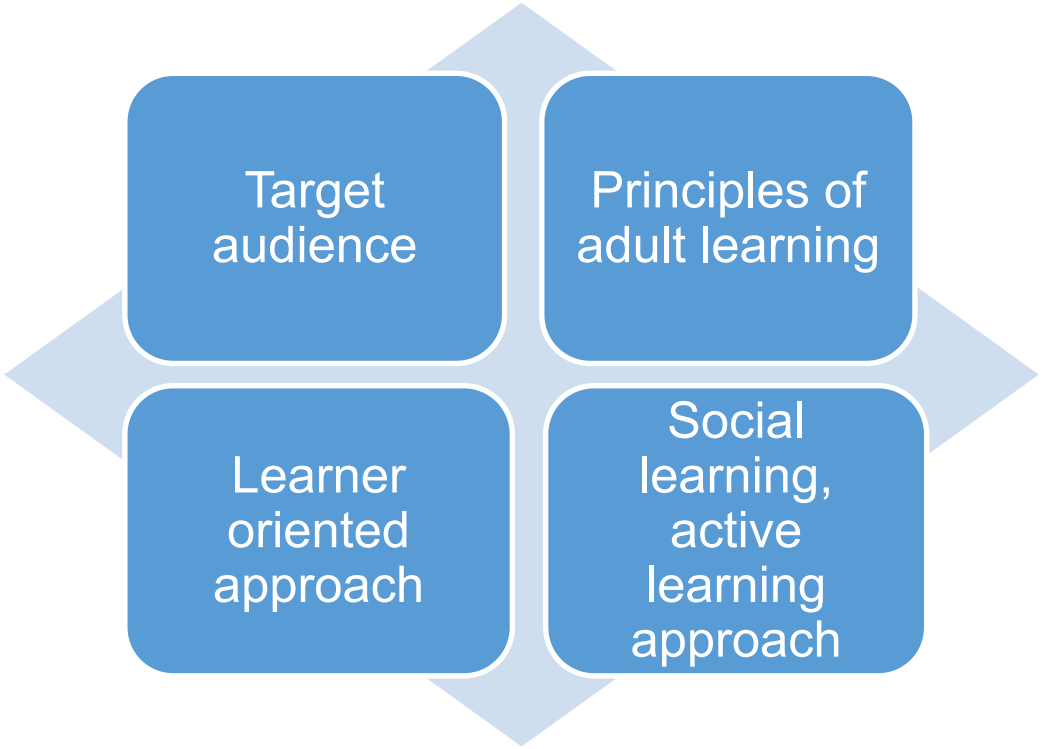
Activity 3: Learning Outcomes

Learning outcome	Bloom's level	Active verb (what participants will be able to do)	Object (what is the item referred to)	Qualifying phrase (for context)
Apply Unix/Linux command-line and write basic shell scripts for automating bioinformatics tasks				
Recognise the different file formats related to genome sequencing data (Illumina, Minion, and ARCTIC protocol outputs)				
Select an appropriate strategy for quality control of NGS data				
Perform reference mapping using different software (e.g. BWA, Bowtie, Novoalign, Tanoti).				
Evaluate genome assemblies using statistics and visualisations				
Use multiple de-novo assemblers for viral genome reconstruction (e.g. SPAdes, ABYSS, IDBA-UD)				
Use metagenomics tools such as KRAKEN and Centrifuge to detect and identify viral pathogens				
Select appropriate software tools to call variants from a genome assembly.				
Compute multiple sequence alignments and construct phylogenetic trees to understand viral evolution and transmission dynamics				
Build a pipeline for analysis, interpretation and identification of viral pathogens.				
Identify effective methods for disseminating knowledge and skills in viral bioinformatics				



Formula for writing LOs:
Use an active verb (what participants will be able to do) + object + qualifying phrase to provide a context.

Training and learning strategies considerations



Remember adult learning principles

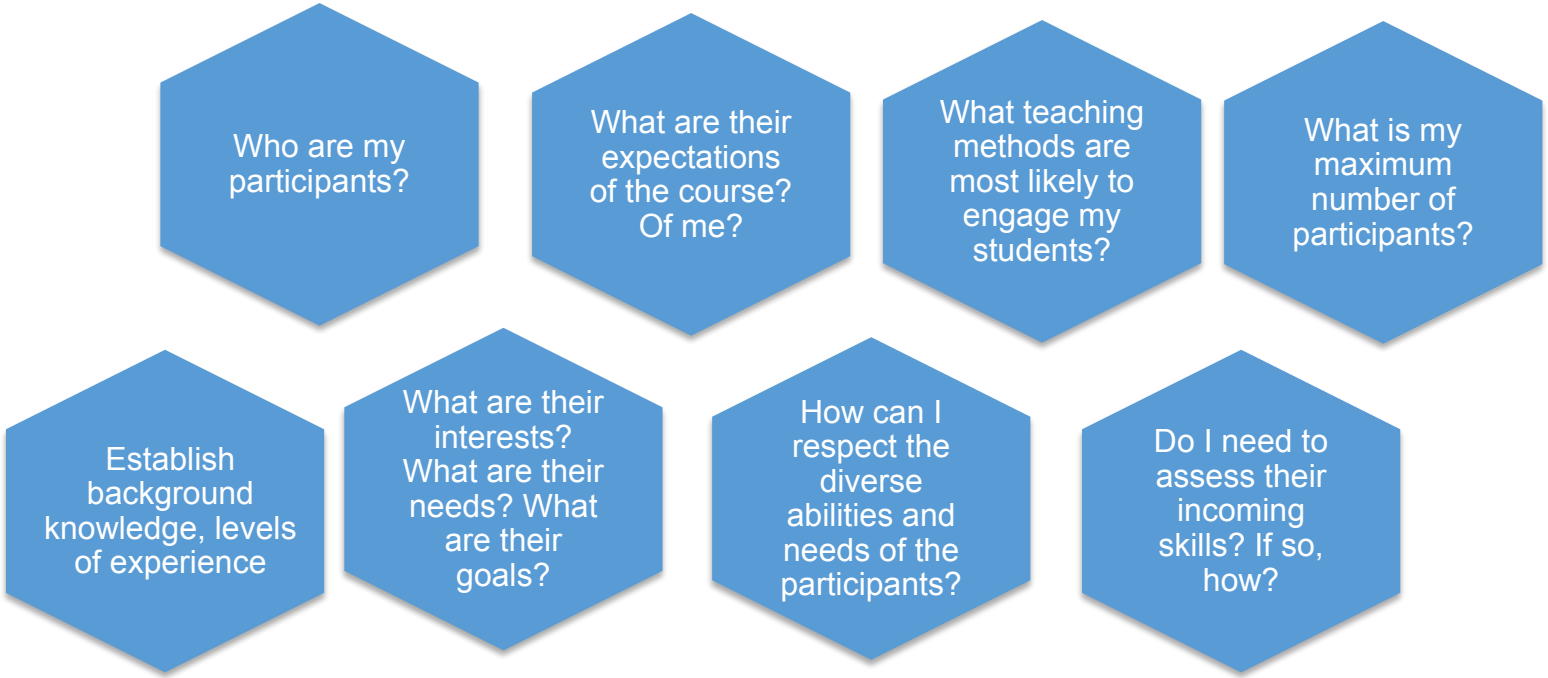
Learning strategies active, self-directed, learner centred

- Since adults are **self-directed**, they should have a say in the content and process of their learning.
- Because adults have so much experience to draw from, their learning should focus on adding to what they have already learned in the past.
- Since adults are looking for practical learning, content should focus on issues related to their work or personal life/career.
- Additionally, learning should be centred on achieving higher cognitive levels beyond memorising content.

Universal Design for Learning (UDL

- Provide multiple means of **engagement** with the subject and learning environment, to support learners' interests. For example, provide varied classroom environments and opportunities to work both collaboratively and alone. Offer learners a choice of ways to learn.
- Provide multiple means of **representation** of learning materials, for example, by offering learning content in different formats so that learners can choose the format that suits them. Same content can be offered in text-based, audio and video formats, or learners could be asked to explore a subject using whatever resources they can find through an online search.
- Provide multiple means of **action and expression** in learning, to provide learners alternatives for demonstrating what they know. For example, by giving learners a choice to write an essay, give a presentation or record a video.

Understand and prepare your target audience



Breaking down content and sequencing

Module 1 – Overview of genomics and pathogen data science

Module 2 - Sample processing, analysis and data QC

Module 3 – Data analysis and integration

Module 3 – Data interpretation

Module 4 – Project: Design your own data analysis pipeline

Week 2

Download RNA-seq data (2 treatments with 2 biol. replicates each) (time: a few minutes).

↓

Optional: Download FastQC software and check quality of RNA reads (time: ~30 minutes).

↓

Download reference genome from database (time: a few minutes).

↓

Build indexed reference genome using preloaded software Bowtie (time: ~ 40 minutes).

↓

Align reads to indexed reference using Tophat (time: ~ 120 minutes).

Week 3

Using tophat output, link transcripts together using Cufflinks (time: ~ 80 minutes).

↓

Cuffmerge merges the individual transcript files (time: ~ 40 minutes).

↓

Cuffdiff calculates differential expression between treatments (time: ~ 180 minutes).

Week 4

Download Cuffdiff output to desktop (time: a few minutes).

↓

Download R, R-Studio, and bioconductor software (time: ~10 minutes).

↓

Use CummeRbund to visualize results in bargraphs and heatmaps (time: ~10 minutes).

↓

Use the R-package TopGO to sortdifferentially expressed genes into functional categories (time: ~20 minutes).

- Prepare the story or case study to use
- Break down the content into manageable chunks

Image Source: [Assessing an effective undergraduate module teaching applied bioinformatics to biology students]

Madlung A (2018) Assessing an effective undergraduate module teaching applied bioinformatics to biology students. PLOS Computational Biology 14(1): e1005872.https://doi.org/10.1371/journal.pcbi.1005872

Designing and developing training materials

- Pre-course preparation (?)
- Itemise resources needed - reagents / equipment / computers / software / internet connectivity
- Course manuals
- Choose relevant datasets
- Existing content?
- Pre-recorded lectures.
- Lecture slides
- Use a repository for developing, sharing and storing training materials

Example training activities

See table 3 of Training design guidelines

- Lecture presentations
- Trainer led teaching
- Expert/guest seminars in specialist topics
- Reflective activities
- Hands-on experimental practicals in laboratory
- Experimental data interpretation
- Hands-on computational practicals analysing WGS data
- Group field work of outbreak scenario
- Scenario-based exercises
- Networking

Active learning exercises - Example

Given a list of available computer components, build a server to satisfy certain computational requirements

Adapted from Dr Anthony Underwood

Starting with a list of steps, build a WGS analysis pipeline.

Guided practical activity

Participants outline their pipeline

Participants present their pipelines

Peer review and discussion

Establishing Capacity
Addis Ababa, Ethiopia

Adapted from Mihir Kekre

A scenario-based exercise

The learning outcomes addressed by the activity included the following: Learners should be able to

1. To design and deliver activities specific to laboratory work in genomic surveillance of antimicrobial resistance: plating live bacteria, bacteria identification and susceptibility testing.
2. To troubleshoot problems that might arise during NGS sequencing of bacterial genomes.
3. To budget appropriately a project on bacterial genomic sequencing.
4. To design a data analysis pipeline for determine AMR variants of the strains

"A scientist is assembling a team tasked with creating a surveillance network to monitor Methicillin-resistant Staphylococcus aureus cases originating from the local hospitals. He needs to establish a baseline for the kind of strains present in the country, as well as the antibiotic resistance patterns displayed. He is running a pilot study using a collection of 4,000 MRSA isolates sampled between 2014 and 2018. The ID and AMR profiles of these isolates have already been determined phenotypically. The aim is to perform whole-genome sequencing (WGS) and use genomic data to determine AMR trends. The budget of the project is $400,000, and the expected timeframe for the pilot study is 24-months. Your task is to submit a project plan detailing how the sequencing will be carried out in the lab, how long it might take to complete and what it will cost him to run this retrospective survey. The objective is to design a LABORATORY ACTION PLAN you wish to carry out in order to be able to sequence 4,000 isolates of Staphylococcus aureus; analyse AMR variants and determine key variants of concern."

Assessment

How do we know if the learners have learnt?

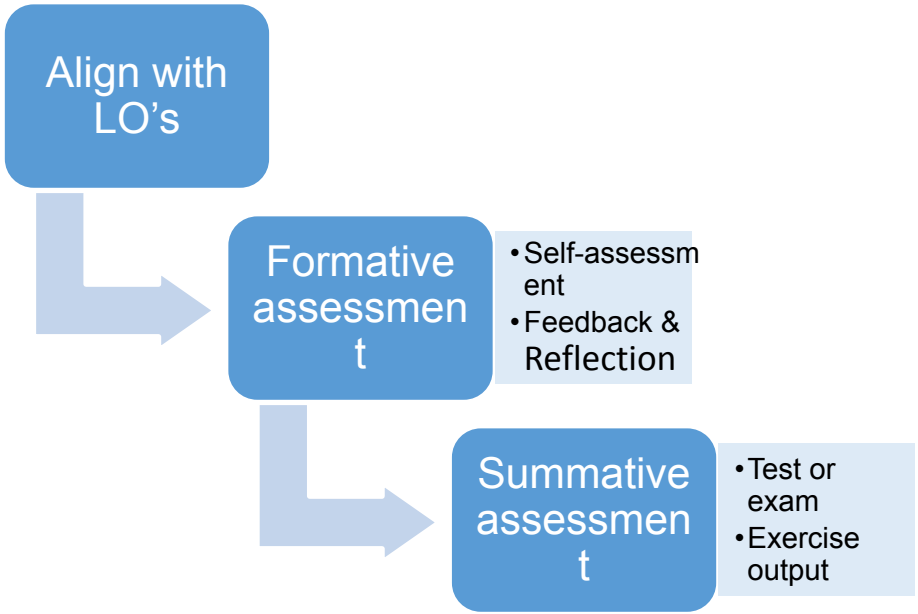
- Assessment for learning
- Assessment of learning

What do you think is the difference?

Assessment for learning
Assessment for learning (formative) – normally qualitative feedback rather than scoring.
Way of assessing learning formally or informally, for the purpose of checking learner's progress as well as effectiveness of the teaching (Bloom)

Assessment of learning
Way of assessing learning has a big impact on learners: students often try to learn what they think they will be assessed.
Assessment of learning (summative) – end of course or distributed throughout the course, normally involves grading.
Often for the purpose of external accountability

Formative and summative assessment



Assessment methods

- Quiz
- Discussions
- Poll
- Peer review
- Practical exercises with expected output

How to use assessment for learning

Activity 4: Assessment Part 1 and Part 2

Assessment Part 1: How to use assessment for learning

- Reflection exercises

Assessment Part 2: Techniques to meaningfully assess learning

- Complete table -
- Make own notes then discuss as a group

Assessment Part 2: Techniques to meaningfully assess learning

- For each of the LO's listed below determine what techniques can learners and trainers use to assess learning (Remember Bloom's levels from remembering to creating)

Learning outcome	Techniques/methods of assessment
Identify appropriate training resources for use in training pathogen genomics and surveillance tools.	
Deliver pathogen genomic data science training to professionals working in genomic epidemiology, surveillance and outbreak investigation.	
Evaluate the self-developed training and knowledge sharing of pathogen genomic data science.	
Create sequencing libraries and analyse samples derived from patients with viral infections.	
Evaluate how to improve the efficiency of NGS by carrying out variations in library preparation technique e.g. target enrichment	
Demonstrate how viral WGS can be used to inform transmission patterns and evaluate the effectiveness of interventions	

Delivery plan considerations and checklist

- Delivery plan tailored to course format/model
- How to implement planned teaching and learning strategies (individual vs group work, lectures vs active learning, embedded formative assessment
- Include a session plan or structure for delivery
- Pre-course materials
- Manuals, computational protocols
- Training team to participants ratio
- Infrastructure and platforms for delivery

Delivery plan article
https://www.futurelearn.com/info/courses/train-the-trainer-design-genomics-training/0/steps/234410

Reflection, Feedback, Evaluation

Training Design Toolkit

Activity 5 - Outline your training

Guidelines	Notes (short bullet points)
Title. Working Title for the Session, Training, Module, Event, Presentation	
Goal and objectives Background and justification - Why is the training needed? What is the big gap or questions which this training fulfil, why is it important, relevant? What is the goal?	
Target audience. Who is this event or training aimed at? What are the pre-requisites.	
Learning outcomes What learners should be able to demonstrate in terms of knowledge, skills and attitudes after the course. At the end of this workshop, participants will be able to…	
Logistic information Venue? Format? Length of training/sessions	
Content. What topics will be covered?	
Activities. What activities, exercises and instructional strategies will be used? What training resources, software, datasets, online tools, datasets, servers?	
Assessment. How can the Learning Outcomes be assesed? Describe the assessment plan and provide details what will be assessed, when and how?	
Delivery. Who will deliver the training/session/presentation? Why	

Activity 5: Design outline

wellcome connecting science

COG-TRAIN COVID-19 GENOMICS GLOBAL TRAINING