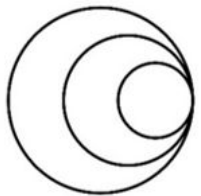


How to design and deliver pathogen genomics training for health and research professionals

Module 1A



**wellcome
connecting
science**



Centre for Genomic
Pathogen Surveillance



References

Learning theories

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives* (Complete ed). Longman.

Bloom's Taxonomy. (n.d.). Vanderbilt University. Retrieved 22 September 2022, from <https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>

Bransford, J., National Research Council (U.S.), & National Research Council (U.S.) (Eds.). (2000). *How people learn: Brain, mind, experience, and school* (Expanded ed). National Academy Press.

Brockett, R. G., & Hiemstra, R. (1991). *Self-direction in adult learning: Perspectives on theory, research, and practice*. Routledge.



References

Conversational Framework screencast. (n.d.). UCL Mediacentral. Retrieved 22 September 2022, from <https://mediacentral.ucl.ac.uk/Player/CG6hD928>

Crosby, R. M. H., Joy. (2000). AMEE Guide No 20: The good teacher is more than a lecturer - the twelve roles of the teacher. *Medical Teacher*, 22(4), 334–347.
<https://doi.org/10.1080/014215900409429>

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2015). *The adult learner: The definitive classic in adult education and human resource development* (Eighth edition). Routledge.

Knowles, M. S. (n.d.). Andragogy, not pedagogy. *Adult Learning*, 16(10), 350-352.

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.



References

Taylor, D. C. M., & Hamdy, H. (2013). Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide No. 83. *Medical Teacher*, 35(11), e1561–e1572.

<https://doi.org/10.3109/0142159X.2013.828153>

What is bloom's digital taxonomy? (n.d.). Retrieved 19 September 2022, from

<https://www.youtube.com/watch?v=fqgTBwEIPzU>

References

Teaching and training strategies for active learning

Abrudan, M., Matimba, A., Nikolic, D., Hughes, D., Argimón, S., Kekre, M., Underwood, A., Aanensen, D. M., NIHR Global Health Research Unit on Genomic Surveillance of Antimicrobial Resistance, Abudahab, K., Harste, H., Muddyman, D., Taylor, B., Wheeler, N., David, S., Donado-Godoy, P., Fabian Bernal, J., Arevalo, A., Fernanda Valencia, M., ... Vegvari, C. (2021). Train-the-trainer as an effective approach to building global networks of experts in genomic surveillance of antimicrobial resistance(Amr). *Clinical Infectious Diseases*, 73(Supplement_4), S283–S289.

<https://doi.org/10.1093/cid/ciab770>

Association for Talent Development (Alexandria, Virginia) (Ed.). (2020). *Talent development body of knowledge: The definitive resource for the talent development profession*. Association for Talent Development.



References

Bioinformatics Education and Training Collection . (n.d.). Retrieved 22 September 2022, from <https://f1000research.com/articles/10-859>

Chapman, B. S., Christmann, J. L., & Thatcher, E. F. (2006). Bioinformatics for undergraduates: Steps toward a quantitative bioscience curriculum. *Biochemistry and Molecular Biology Education*, 34(3), 180–186. <https://doi.org/10.1002/bmb.2006.49403403180>

Compeau, P. (2019). Establishing a computational biology flipped classroom. *PLoS Computational Biology*, 15(5), e1006764. <https://doi.org/10.1371/journal.pcbi.1006764>

Davies, A. C., Harris, D., Banks-Gatenby, A., & Brass, A. (2019). Problem-based learning in clinical bioinformatics education: Does it help to create communities of practice? *PLOS Computational Biology*, 15(6), e1006746. <https://doi.org/10.1371/journal.pcbi.1006746>



References

Emery, L. R., & Morgan, S. L. (2017). The application of project-based learning in bioinformatics training. *PLOS Computational Biology*, 13(8), e1005620.

<https://doi.org/10.1371/journal.pcbi.1005620>

Introduction to genomics and bioinformatics | lab training course | biograd. (n.d.). Retrieved 22 September 2022, from <https://www.biograd.co.uk/introduction-to-geomics-and-bioinformatics.php>

Lexnederbragt. (2015, August 31). Active learning strategies for bioinformatics teaching. *In between Lines of Code*.

<https://flxlexblog.wordpress.com/2015/08/31/active-learning-strategies-for-bioinformatics-teaching-2>



References

- Magana, A. J., Taleyarkhan, M., Alvarado, D. R., Kane, M., Springer, J., & Clase, K. (2014). A survey of scholarly literature describing the field of bioinformatics education and bioinformatics educational research. *CBE—Life Sciences Education*, 13(4), 607–623. <https://doi.org/10.1187/cbe.13-10-0193>
- McGrath, A., Champ, K., Shang, C. A., Dam, E. van, Brooksbank, C., & Morgan, S. L. (2019). From trainees to trainers to instructors: Sustainably building a national capacity in bioinformatics training. *PLOS Computational Biology*, 15(6), e1006923. <https://doi.org/10.1371/journal.pcbi.1006923>
- Pawlik, A., Gelder, C. W. G. van, Nenadic, A., Palagi, P. M., Korpelainen, E., Lijnzaad, P., Marek, D., Sansone, S.-A., Hancock, J., & Goble, C. (2017). *Developing a strategy for computational lab skills training through Software and Data Carpentry: Experiences from the ELIXIR Pilot action* (6:1040). F1000Research. <https://f1000research.com/articles/6-1040>

References

- Schoenborn, P., Osborne, R., Toms, N., Johnstone, K., Milsom, C., Muneer, R., Jarvis, M. A., & Belshaw, R. (2019). OncoSim and OncoWiki: An authentic learning approach to teaching cancer genomics. *BMC Medical Education*, 19(1), 407. <https://doi.org/10.1186/s12909-019-1812-7>
- Tofade, T., Elsner, J., & Haines, S. T. (2013). Best practice strategies for effective use of questions as a teaching tool. *American Journal of Pharmaceutical Education*, 77(7), 155. <https://doi.org/10.5688/ajpe777155>
- UNESCO Office Bangkok and Regional Bureau for Education in Asia and the Pacific. (2018). *Preparing teachers for global citizenship education: A template.*

References

Zhou, L., Watzlaf, V., & Abdelhak, M. (2013). Flexible approaches for teaching computational genomics in a health information management program. *Perspectives in Health Information Management / AHIMA, American Health Information Management Association*, 10(Summer), 1b.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3709875/>

平田, たつみ, Gorman, T., & 広海, 健. (2016). 遺伝研メソッドで学ぶ科学英語プレゼンテーション: 感じる力、考える力、討論する力を育てる. dZERO インプレス (発売).

Training and teaching design

Bioinformatics for Biologists: An Introduction to Linux, Bash Scripting, and R. (n.d.).
<https://www.futurelearn.com/courses/linux-for-bioinformatics>



References

Curriculum Development and Evaluation Guide. (n.d.).

<https://appd.s3.amazonaws.com/docs/meetings/2013SpringPresentations/PCWS1Handout.pdf>

Gutierrez, K. (n.d.). *A quick guide to four instructional design models—Shift e-learning*. Retrieved 22 September 2022, from

<https://www.shiftelearning.com/blog/top-instructional-design-models-explained>

Instructional design. (n.d.). Retrieved 22 September 2022, from

<https://www.umt.edu/umonline/services-and-support/instructional-design/default.php>

Khalil, M. K., & Elkhider, I. A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education*, 40(2), 147–156.

<https://doi.org/10.1152/advan.00138.2015>



References

McClatchy, S., Bass, K. M., Gatti, D. M., Moylan, A., & Churchill, G. (2020). Nine quick tips for efficient bioinformatics curriculum development and training. *PLOS Computational Biology*, 16(7), e1008007. <https://doi.org/10.1371/journal.pcbi.1008007>

MODELS OF COURSE DESIGN AND STEPS FOR COURSE DEVELOPMENT. (n.d.). University of Toronto Faculty of Medicine.
<https://www.cpd.utoronto.ca/wp-content/uploads/2016/07/P02-Models-of-course-design-and-steps-for-course-development-1.pdf>

Resources. (n.d.). *Visualising Data*. Retrieved 19 September 2022, from <https://www.visualisingdata.com/resources/>



References

Tractenberg, R. E., Lindvall, J. M., Attwood, T., & Via, A. (2020). *Guidelines for curriculum and course development in higher education and training* [Preprint]. SocArXiv.

<https://doi.org/10.31235/osf.io/7qeht>

UDL: The UDL Guidelines. (n.d.). Retrieved 19 September 2022, from <https://udlguidelines.cast.org/>

Valverde-Berrocoso, J., & Fernández-Sánchez, M. R. (2020). Instructional design in blended learning: Theoretical foundations and guidelines for practice. In A. V. Martín-García (Ed.), *Blended Learning: Convergence between Technology and Pedagogy* (pp. 113–140). Springer International Publishing.

https://doi.org/10.1007/978-3-030-45781-5_6

Via, A., Palagi, P. M., Lindvall, J. M., Tractenberg, R. E., Attwood, T. K., & Foundation, T. G. (2020).

<p>course design: Considerations for trainers – a professional guide</p>. *F1000Research*,

9(1377), 1377. <https://doi.org/10.7490/f1000research.1118395.1>



References

Learning environments

Academy, E. (2020, August 30). Why are virtual labs crucial for the “new normal”? *Enago Academy*.

<https://www.enago.com/academy/why-are-virtual-labs-crucial-for-the-new-normal/>

Characteristics of a positive learning environment. (n.d.). Human Kinetics. Retrieved 22 September

2022, from

<https://us.humankinetics.com/blogs/excerpt/characteristics-of-a-positive-learning-environment>

Sköld, O. (2012). The effects of virtual space on learning: A literature review. *First Monday*.

<https://doi.org/10.5210/fm.v17i1.3496>

References

Technological pedagogical content knowledge. (2022). In *Wikipedia*.

https://en.wikipedia.org/w/index.php?title=Technological_pedagogical_content_knowledge&oldid=110025346

Competencies

Competency Hub Supporting competency-based training and professional development. (n.d.).

International Society for Computational Biology (ISCB).

<https://competency.ebi.ac.uk/framework/iscb/3.0>



References

Developing clinical bioinformatics training in the nhs. (n.d.). *Genomics Education Programme*.

Retrieved 22 September 2022, from

<https://www.genomicseducation.hee.nhs.uk/documents/developing-clinical-bioinformatics-training-in-the-nhs/>

DigCompEdu. https://joint-research-centre.ec.europa.eu/digcompedu_en. Accessed 22 Sept. 2022.

Jenkins, J., Calzone, K. A., Caskey, S., Culp, S., Weiner, M., & Badzek, L. (2015). Methods of genomic competency integration in practice. *Journal of Nursing Scholarship : An Official Publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau*, 47(3), 200–210.

<https://doi.org/10.1111/jnu.12131>



References

Laudadio, J., McNeal, J. L., Boyd, S. D., Le, L. P., Lockwood, C., McCloskey, C. B., Sharma, G., Voelkerding, K. V., & Haspel, R. L. (2015). Design of a genomics curriculum: Competencies for practicing pathologists. *Archives of Pathology & Laboratory Medicine*, 139(7), 894–900.

<https://doi.org/10.5858/arpa.2014-0253-CP>

Mulder, N., Schwartz, R., Brazas, M. D., Brooksbank, C., Gaeta, B., Morgan, S. L., Pauley, M. A., Rosenwald, A., Rustici, G., Sierk, M., Warnow, T., & Welch, L. (2018). The development and application of bioinformatics core competencies to improve bioinformatics training and education.

PLoS Computational Biology, 14(2), e1005772. <https://doi.org/10.1371/journal.pcbi.1005772>

References

- Nembaware, V., African Genomic Medicine Training Initiative, Mulder, N., Abidi, O., Akanle, M., Ali, S. A., Aliga, C. A., Chauke, P., Cotzee, M., Dandara, C., Fadlelmola, F. M., Fawale, M. B., Fernandes, P. L., Ghansah, K., Kashim, Z. A., Kassim, S. K., Komolafe, M. A., Landouré, G., Leisegang, C., ... Wessels, T.-M. (2019). The african genomic medicine training initiative (Agmt): Showcasing a community and framework driven genomic medicine training for nurses in africa. *Frontiers in Genetics*, 10. <https://www.frontiersin.org/articles/10.3389/fgene.2019.01209>
- Scoresby, J., Tkatchov, M., Hugus, E., & Marshall, H. (2018). Applying service design in competency-based curriculum development. *The Journal of Competency-Based Education*, 3(3), e01171. <https://doi.org/10.1002/cbe2.1171>



References

- Tognetto, A., Michelazzo, M. B., Ricciardi, W., Federici, A., & Boccia, S. (2019). Core competencies in genetics for healthcare professionals: Results from a literature review and a Delphi method. *BMC Medical Education*, 19(1), 19. <https://doi.org/10.1186/s12909-019-1456-7>
- Tractenberg, R. E., Lindvall, J. M., Attwood, T. K., & Via, A. (2019). The Mastery Rubric for Bioinformatics: A tool to support design and evaluation of career-spanning education and training. *PLOS ONE*, 14(11), e0225256. <https://doi.org/10.1371/journal.pone.0225256>

Evaluation

- Brown, J. A. L. (2016). Evaluating the effectiveness of a practical inquiry-based learning bioinformatics module on undergraduate student engagement and applied skills: Teaching Practical Bioinformatics. *Biochemistry and Molecular Biology Education*, 44(3), 304–313. <https://doi.org/10.1002/bmb.20954>



References

Evaluation handbook. (n.d.). Retrieved 19 September 2022, from <https://wkkf.issuelab.org/resource/evaluation-handbook.html>

FutureLearn. (n.d.). *Page from online teaching: Evaluating and improving courses - the open university*. FutureLearn. Retrieved 22 September 2022, from <https://www.futurelearn.com/courses/online-teaching-evaluating-what-works/1/register>

Harvard University Program on Survey Research. (n.d.). https://psr.iq.harvard.edu/files/psr/files/PSRQuestionnaireTipSheet_0.pdf

Kirkpatrick, D. L., & Kirkpatrick, J. D. (2006). *Evaluating training programs: The four levels* (3rd ed). Berrett-Koehler.

References

Metrics for Evaluating Effectiveness of Genomics Education and Training Programs. (n.d.). National Human Genome Research Institute.

https://www.genome.gov/Multimedia/Slides/IntlGenomicsEducation/JenkinsJ_metrics.pdf

Needs assessment for informing extension professional development trainings on teaching adult learners. (n.d.). The Journal of Extension (JOE). Retrieved 22 September 2022, from

<https://archives.joe.org/joe/2018june/a1.php>

What is evaluation? (2020, April 25). BetterEvaluation.

<https://www.betterevaluation.org/en/what-evaluation>

References

FAIR

Bioschemas—1.0 Release. (n.d.). Retrieved 22 September 2022, from <http://bioschemas.org/profiles/TrainingMaterial/1.0-RELEASE>

Garcia, L., Batut, B., Burke, M. L., Kuzak, M., Psomopoulos, F., Arcila, R., Attwood, T. K., Beard, N., Carvalho-Silva, D., Dimopoulos, A. C., Angel, V. D. del, Dumontier, M., Gurwitz, K. T., Krause, R., McQuilton, P., Pera, L. L., Morgan, S. L., Rauste, P., Via, A., ... Palagi, P. M. (2020). Ten simple rules for making training materials FAIR. *PLOS Computational Biology*, *16*(5), e1007854. <https://doi.org/10.1371/journal.pcbi.1007854>

References

Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., ... Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 160018. <https://doi.org/10.1038/sdata.2016.18>

Resources

- [WCS resources](#)
- [WCS GitHub repositories](#)
- [EMBL-EBI support for trainers](#)
- [GOBLET](#)
- [Elixir](#)
- [Train the Trainer](#)
- [EBI Competency hub](#)

Acknowledgements

This course was developed by a collaboration between the [Centre for Genomic Pathogen Surveillance](#) and [Wellcome Connecting Science](#). It was brought to you by [T3Connect – Data Science and Genomic Pathogen Surveillance Training Programme](#), funded by [UKRI](#).

This module contains materials from the following sources:

- [Storyset | Customize, animate and download illustration for free](#)

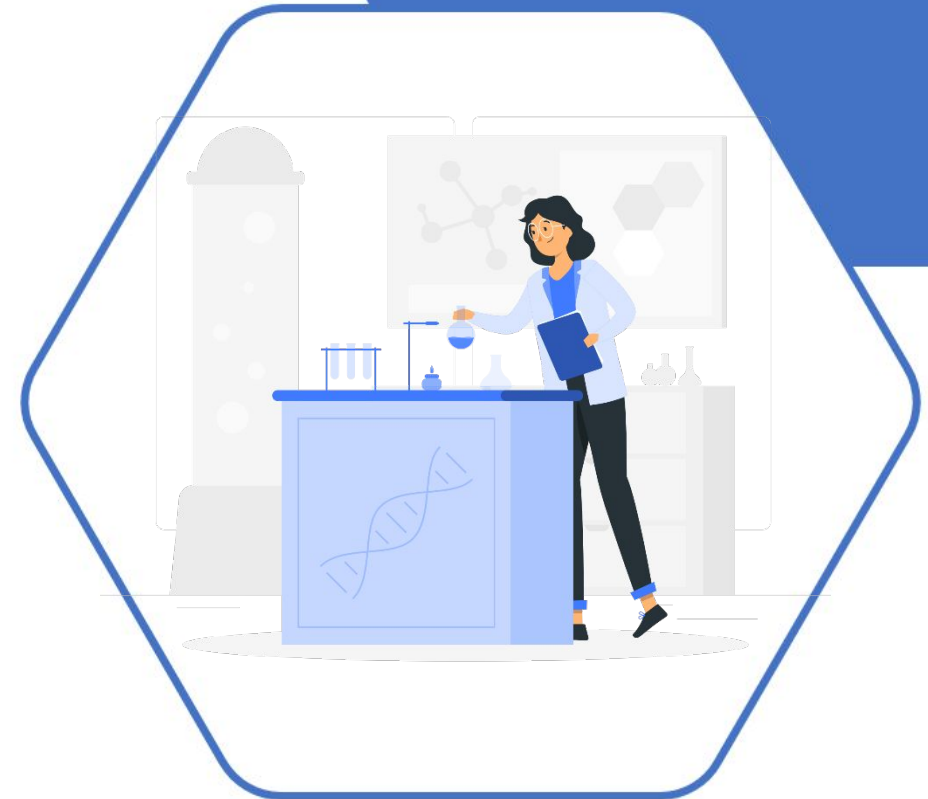


Creative Commons

This work is licensed under a [Creative Commons Attribution-Share Alike Licence \(CC BY-SA 4.0\)](https://creativecommons.org/licenses/by-sa/4.0/).



**Attribution-ShareAlike 4.0 International
(CC BY-SA 4.0)**



Thank you

