STEM By Nature & Citizen Science: #14 Life Below Water

STEM By Nature: STEM teaching & learning in nature settings, using outdoor learning approaches

Guidance for a 2-3-hour training session

This session introduces and explores what is meant by 'STEM By Nature' and how it can be applied in relation to Citizen Science and Social Action. It can be adapted to suit a range of locations and group/learner needs. Its audience is teachers and other educators, including youth workers, outdoor instructors, Countryside Rangers. Whilst some facilitation and group management skills are needed, it's designed to be delivered by non-specialists – you do not need to be an expert in STEM learning or the outdoors.

STEM By Nature & Citizen Science – Aims

- Build STEM skills and confidence through the use of nature settings and Outdoor Learning approaches.
- Introduce and explore the concept of STEM By Nature through citizen science information, resources and activities around the theme of #14 Life Below Water.
- Highlight Curriculum for Excellence and STEM connections, including examples and opportunities for:
  - Interdisciplinary Learning and the process of enquiry
  - showing how Citizen Science can relate to the 4 Contexts, equity and work skills.

Structure and Content

Information, resources and activities relating to Citizen Science and UN Sustainable Development Goal #14 Life Below Water are signposted throughout. Connections can be made with other UN Sustainable Development Goals or themes such as creativity in STEM learning. A session can be delivered to give a broad overview of links between STEM, Citizen Science and #14 Life Below Water, or adapted to focus on a particular theme or context.

This Citizen Science: #14 Life Below Water session is part of a growing portfolio of STEM By Nature session guidance, hosted on the John Muir Trust website here. Other sessions in the STEM By Nature series include - An Introduction, Citizen Science: #15 Life On Land, UN Sustainable Development Goals and #13 Climate Action. Explore the STEM By Nature Resources and Links padet which has useful links relating to each relevant UN Sustainable Development Goal.

See here for a session guidance for STEM By Nature: Trees, Woods and Forests, created by Rob Bushby for Scottish Forestry.

Introduction

Introduction to STEM By Nature, its origins and rationale. Confirm STEM By Nature as '**STEM teaching & learning in nature settings, using Outdoor Learning approaches**'.
Note that it's a broad concept and an approach, not just a Professional Learning session or specific subject.
Outline session aims.
Note the inclusive 'educator' audience; session has relevance to a wide range of ages and backgrounds, not just schools/teachers.

Icebreaker
As participants gather set an ice-breaking task with an open, leading question such as:

- 'How familiar are you with wildlife surveys and 'Citizen Science'?'
- 'Do you do anything you'd describe as 'Citizen Science' or 'Social Action'?' Collate responses on flip chart, share with group.

Citizen Science and Social Action
Explain what is meant by Citizen Science - using the Education Scotland and/or FSC resource. Citizen Science is "getting everyone, from experts to amateur biologists, school children to enthusiastic beginners involved in science" (TCV). More formally, it involves the gathering, recording and analysis of scientific data by members of the public.
Citizen Science covers a range of activities and skills including:

- observing and monitoring e.g. gathering data to find out about wildlife populations
- informing action e.g. providing data to organisations about floods or pollution
- promoting learning e.g. informing learners with information about climate change
- testing hypotheses e.g. using science activities to test a specific question
- crowd-sourcing e.g. online activities to gather or analyse data to achieve a common goal
- helping communities learn about their local environment.

Youth social action refers to activities that young people do to make a positive difference to others and/or the environment. It can take place in a range of contexts and include formal or informal activities such as volunteering, fundraising, campaigning or supporting peers – including Citizen Science.

Note that opportunities to make links with Interdisciplinary Learning and to explore equity in STEM learning can be shared. See STEM By Nature - An Introduction for more on these, and 'Interdisciplinary Learning: ambitious learning for an increasingly complex world'.
Reference STEM employability skills and their relevance to Citizen Science.

Pupil/learner enquiry

Pupil enquiry refers to learners deciding for themselves, carrying out their own independent investigations, with teachers adopting a facilitator role to develop skills and nurture inquiring attitudes.

A *Spectrum of Enquiry*, drawn from fieldwork practice, relates to a range of STEM skills and can be used to set up, deliver and review Citizen Science experiences:

Sensing - Framing - Questioning - Observing - Analysing/Interpreting - Concluding

Consider the relative importance of each of these elements in your activities/session, and in wider education settings. How do these elements inter-connect? How do they relate to STEM subjects? Which are you/your learners good at?

Outdoor Session

(1-2 hours – adapt inputs/activities for time available)

Activities are presented as introductions, options and 'tasters' rather than fully delivered. This is to keep within a limited timeframe, to share a wide variety of ideas, and to keep things punchy.

Select, plan and frame activities to include and demonstrate, as far as possible:

- ways to build confidence and skills in STEM teaching and learning
- active, cognitive, creative approaches
- opportunities to consider methods of Pupil Enquiry, sustainability themes, and Interdisciplinary Learning
- 4 STEM subject areas of Science, Technology, Engineering, Maths
- resources available to support participants beyond this session.

Act Like a Victorian Explorer (Link to Science, Literacy, Biodiversity)

Walk everywhere carrying only a light blanket, tea, bread and a notebook and pencil. Choose some plants and animals and make up your own names for them according to what they look like or what they do. Record your own names and ask others to guess what you have spotted. Find out the 'real' names for what you have found. Mission:Explore Muir Mission

Discuss briefly. In pairs, share at least one connection between #14 Life Below Water and STEM (e.g. awareness of an activity, resource, subject link).

Citizen Science surveys

Carry out a freshwater/marine-based survey as appropriate for the time of year and the habitat, see below for examples including rocky shore and freshwater surveys and bioblitz as well as litter surveys.

Introduce tools to help with identification: iSpot, FSC guides, and other free apps e.g. Zepto from NatureScot.

Reference: John Muir Award Surveys Resource Guide

Reference: FSC Field Work Live

Reference: NatureScot Citizen Science for Biodiversity

Reference: Scotland's Environment Web Project Finder

Rocky Shore/Freshwater sampling techniques (Science)
Demonstrate a range of techniques to collect/observe organisms e.g. taking photographs, kick sampling, pond dipping, how to safely collect invertebrates, responsible collection of seaweed, etc. The FSC's B-Wild: Rocky Shore is a good place to start for an introduction to the rocky shore, and OPAL Water Survey can help with the survey process for freshwater and includes identification guides. Submit findings to iSpot/iRecord to inform ongoing research, or collect on an app such as Zepto or Seek (which gives badges according to how many species are found), or create your own monitoring process.

Give participants the opportunity to trial techniques and explore use of tools, apps.
Re-group and review, highlighting opportunities to develop STEM skills (observation, description, measuring, recording etc.).

Marine/coastal surveys (Science, Maths, Technology and Process of Enquiry)
A number of surveys can be carried out in the marine and coastal environment, from casual sightings of whales (Whale Track) and other cetaceans (Sea Watch Foundation), to more in-depth surveys such as the Big Seaweed Search or take part in the effort to map seagrass, an important natural climate solution in terms of its ability to soak up carbon, using the SeagrassSpotter app.

Freshwater surveys (Science, Maths, Technology and Process of Enquiry)
If there is access to a pond, the Big Pond Dip contains resources to survey the pond, calculate the health of the pond, and gives suggestions on how to improve the habitat. The Mammal Society is also encouraging individuals and groups to record the small mammals they find along waterways through their Walk this Waterway survey. Explore the world of reptiles and amphibians using the Garden Dragon Watch, and consider setting up a weather station to record rainfall and other measurements. A guide from the Royal Meteorological Society gives hints and tips, and casual recordings can be entered on the WOW website.

Litter surveys (Science, Maths, Technology and Process of Enquiry)
If access to water is not an option, litter surveys are a good way to engage with #14 Life Below Water e.g. Keep Scotland Beautiful Upstream Battle can help with the survey process, and if you have access to beach, riverbank, lakeside or coastline there are other international surveys for marine plastics such as the Big Microplastic Survey and The Great Nurdle Hunt or plan a beach clean and register your event with the Marine Conservation Society to record your results.

Bioblitz (Science, Biodiversity)
"Bioblitz: capturing a snapshot of an area's biodiversity before the clock runs out!"
Introduce the concept. An 'official' Bioblitz event lasts 24hrs, but observations from a scaled-down version (e.g. school grounds in an afternoon, or on a walk) can be effective.
Set up a short illustrative Bioblitz e.g. see how many species in a defined area can be found in 20 minutes. Have a selection of FSC field guides available to help with identification and signpost to iSpot as an online tool of experts for support.
Highlight the free training provided by Open Learn: Citizen Science and Global Biodiversity.

Review Activities

STEM Skills

Review each of the session's outdoor activities using the STEM employability skills to highlight particular skills used and/or developed. What subject (Science, Technology, Engineering, Maths) outcomes have we covered during our Citizen Science activity? Which STEM Skills have we used (numeracy/ IT Skills, Problem Solving, Valuing Diversity, Communications, Teamwork, Negotiation, Initiative, Deadlines, Adaptable, organisational). How could you build on this outdoors/ indoors? Add review comments to large display on board/flip chart as participants return indoors.
Consider which aspects of the **Spectrum of Enquiry** have featured in activities, and how they relate to STEM skills: **Sensing - Framing - Questioning - Observing - Analysing/Interpreting - Concluding**

Introduce the STEM Self-evaluation and Improvement Framework: "a framework to stimulate dialogue and action towards a whole setting approach STEM". It can be integrated with the quality indicators within 'How good is our school?' and 'How good is our early learning and childcare?' The framework aligns with expectations within the STEM Education and Training Strategy, Developing the Young Workforce and other priorities in education.

Signposting and wrap up

Open discussion/round robin: "What can you take away with you from this session?"
Introduce STEM By Nature Resources and Links padlet: a place to collate relevant and referenced resources (along with other relevant locations e.g. Glow).
Create a padlet to share participant conversations and activities arising from the session.
Note use of relevant hashtags for social media sharing, including #STEMByNature.

Local Learning Task suggestions

Use local settings outside to try out some of the Citizen Science examples encountered.
Encourage sharing of photos/quotes/tweets/social media.
Discuss ways to make use of the STEM Self-evaluation and Improvement Framework with colleagues.

Citizen Science Resources – links and signposting

Have hard copies (or web access and links) of these resources available for participants to view.
Education Scotland Citizen Science & Curriculum for Excellence overview (great starting point)
FSC Field guides and FSC Field Work Live
iRecord - collate wildlife sightings to support research at local and national levels
Digimap - data collections, including OS, historical, geological, marine maps and spatial data
TCV's Citizen Science pages
Juliet Robertson's (author of 'Dirty Teaching: a beginners guide to learning outdoors'), comprehensive Index of ideas and articles.
John Muir Award Surveys Resource Guide
John Muir Award Sustainability Resource Guide
John Muir Award and Curriculum for Excellence

Leaders' Notes

Equipment (suggested)

Any equipment available to help with wildlife observation e.g. magnifying glasses, binoculars, nets, buckets and trays or pots for collecting creatures.
Identification guides e.g. FSC publications, tablets/devices for taking photos.
Print-out or hard copies of OPAL Water Quality Survey.
Clip boards, paper, pencils.

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