

# Lesson Plan: Breathless Oceans: Impact of Climate Change on Dissolved Oxygen

<Header Image: <https://elements.envato.com/water-bubble-underwater-blue-background-RFEWW6L> >

## Overview

As a **high school** or introductory **undergraduate Chemistry** or **Environmental Sciences** teacher, you can use these computer based tools to teach a **practical component** of **environmental chemistry paper** i.e. the determination of dissolved oxygen in the given sample of water.

In this lesson plan, students will be introduced to the term 'dissolved oxygen' and understand the correlation between increase in global temperatures and declining oxygen levels in the oceans. The students will further learn about the impact of low oxygen levels on aquatic life and food webs.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in Chemistry or Environmental Sciences.

## Learning Outcomes

The tools in this lesson plan will enable students to:

- Understand the importance of dissolved oxygen in the maintenance of marine ecosystems.
- Enable students to critically think about the human activities responsible for depleting oxygen levels in water bodies.
- Understand the principle and reactions involved and the role of each reagent used in the experimental determination of dissolved oxygen.
- Understand how the increase in global temperatures also enhances the salinity of the ocean and thus impacts the levels of oxygen there.

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Want to know more about how to contribute? Contact us.

## About

Grade Level	High School, Undergraduate
Discipline	Chemistry, Environmental Sciences
Topic(s) in Discipline	Environmental Chemistry, Hydrosphere, Dissolved Oxygen, Water Pollution, Analytical Chemistry, Industrial Chemistry
Climate Topic	Climate and the Atmosphere, Climate and the Biosphere, Climate and the Hydrosphere
Location	Global

Access	Online
Language(s)	English
Approximate Time Required	90-120 mins
Mapped Sustainable Development Goal(s), apart from 4 and 13	14: Life below water

## Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1	<p>Introduce the topic by playing a video micro-lecture</p> <p>Video (5 mins)</p>	<p>Use the video micro-lecture titled, “Dissolved Oxygen” by Massachusetts Institute of Technology to help students understand the meaning of dissolved oxygen. Use this video to explain the various sources which maintain the oxygen levels in the water body, like photosynthesis by plants and phytoplanktons. Further discuss how the increase in global temperatures is responsible for decreasing the oxygen holding capacity of water bodies. This video can also be used to state factors, other than global warming, that are responsible for the declining oxygen levels in water and the precautions which can be taken to keep the oxygen levels in check .</p> <p>This can be accessed <a href="#">here</a>.</p>
2	<p>Explore the topic further by playing a video micro-lecture</p> <p>Video (5 mins)</p>	<p>This video micro-lecture titled, “Ocean Deoxygenation: Our Ocean's Oxygen Supply &amp; Demand Issue” produced by Ocean Scientist for Informed Policy (OSIP) can be used to further emphasize how climate change is causing an imbalance in the oxygen demand and supply in the oceans. This alteration in ocean dynamics through decreasing oxygen supply also results in an increase in the biological oxygen demand (BOD). Increasing BOD is responsible for further lowering of oxygen levels in the oceans negatively impacts the aquatic ecosystem. The video can also be used to explain the seriousness of the concern through some oxygen minimum zones which are already present in some of the oceans and are expanding horizontally as well as vertically. These zones already have a negative impact on those marine lives which are more sensitive to this low oxygen situation.</p> <p>This can be accessed <a href="#">here</a>.</p>
3	<p>Demonstrate how it is related to climate change through this reading</p> <p>Reading (10 min)</p>	<p>This reading titled, “Guest post: How global warming is causing ocean oxygen levels to fall” briefly explains the dangers of deoxygenation and the possible reasons of global warming which is directly proportional to the marine oxygen loss. In this reading material the charts depicting the changing oxygen levels over the years have been presented. Most importantly, in this reading material, there is an embedded link that takes the readers to the latest review published by “Nature Geoscience” which discusses the Drivers and Mechanisms of oxygen deoxygenation.</p>

		This can be accessed <a href="#">here</a> .
4	Laboratory Activity: Determination of Dissolved Oxygen by Winkler's titration method  Classroom/Laboratory Activity (60 mins)	Winkler's method is the most common titrimetric method used to estimate the amount of dissolved oxygen in the water sample. In this method, the oxygen present in the water sample is used to oxidize iodide ions to iodine, quantitatively. This classroom/laboratory activity titled, "Determination of Dissolved Oxygen by Winkler Titration" explains the principle, apparatus and chemicals required, the reactions involved and step by step procedure to be followed by the students and how to calculate the oxygen levels using these results.  This can be accessed <a href="#">here</a> .

## Questions

Use this Lesson Plan to help the students to understand and find answers to:

1. What is dissolved oxygen? What are the sources of oxygen in the water body?
2. Is the lowering of oxygen levels in the oceans a geological phenomenon Or do you think human activities are responsible for it. Justify
3. How does the elevation in global temperature affect the marine ecosystem?
4. How the decline in oxygen levels has a negative impact on the marine ecosystem?
5. What do you understand by oxygen minimum zone? Why are these expanding?
6. Name some of the aquatic species that are most impacted because of low oxygen levels.
7. What is eutrophication? Why is it harmful?
8. What is the principle of Winkler's method of Dissolved oxygen determination?
9. Write the reaction involved in the estimation of dissolved oxygen by Winkler's method.
10. What is the role of starch in this titration?

## Additional Resources

(Optional)

1.	Reading (5-8 mins)	A reading material at Scientific American magazine which relates the increasing CO <sub>2</sub> levels in the atmosphere to the decreasing oxygen in water bodies  This can be accessed <a href="#">here</a> .
2.	Reading (5-8 mins)	Another press release by UNESCO which talks about the raising concern about the low oxygen levels in oceans.  This can be accessed <a href="#">here</a> .
3.	Video (10 mins)	This video explains the experimental determination of effect of salinity and temperature on Dissolved Oxygen. As global temperature increases, the solubility of salts in water also increase which impacts the DO levels.  This can be accessed <a href="#">here</a> .
4.	Reading (5-7 mins)	Reading at Webpage of IOC-UNESCO Global Ocean Oxygen Network (GO <sub>2</sub> NE) on Declining oxygen in the world's ocean: 15 things to know  This can be accessed <a href="#">here</a> .

5.	Read (60 mins)	Read the sections 2.1, 3.1, 3.2 and 3.3  This can be accessed <a href="#">here</a> .
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### Credits

1.	Video lecture-1 “Dissolved Oxygen”	Massachusetts Institute of Technology, You Tube
2.	Video lecture-2 “Dissolved Oxygen”	Natalya Gallo at the Scripps Institution of Oceanography, you tube
3.	Reading (PDF)	<a href="https://www.carbonbrief.org/">https://www.carbonbrief.org/</a>
4.	Laboratory Experiment	Massachusetts Institute of Technology
5.	Additional Reading	<ol style="list-style-type: none"> <li>1. Article at Scientific American magazine</li> <li>2. UNESCO</li> <li>3. Kilroy Academy, you tube</li> <li>4. of IOC-UNESCO Global Ocean Oxygen Network (GO<sub>2</sub>NE)</li> <li>5. The International Union for Conservation of Nature</li> </ol>