 Depth study – Observations

Module 1: Cause and effect - observing

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Suggested time allocated: 3 hours

Context

In this module, students are required to make qualitative and quantitative observations and specifically analyse the quantitative data of the pH of acids and bases. It is also suggested that students carry out a practical activity to quantitatively and qualitatively describe the characteristics of acids and bases. For these reasons, the context for this depth study is acids and bases. During this sequence of learning, students can draw on their prior knowledge of everyday substances familiar to them. Students could investigate the acidity of soft drinks and factors affecting acidity. They might compare the acidity of different fruit juices or could relate the acidity of household products to their uses. Students could also investigate the acidity of hair products and their effects.

Key inquiry questions

* How does observation instigate scientific investigation?
* What are the benefits and drawbacks of quantitative and qualitative observations?
* How does primary data provide evidence for further investigation?
* How does the collection and presentation of primary data affect the outcome of scientific investigation?

Overview

In this sequence of learning, students build on their prior knowledge and understanding of acids and bases. They engage in learning that develops surface knowledge through acquisition and consolidation. Students then have opportunities to develop deep knowledge and transfer this to new learning. Teacher and student feedback is integrated throughout and essential to the learning process. While the context presented is acids and bases, this learning model can be readily used in other contexts and include many other teaching and learning strategies.

This model of learning is based on the principles of Visible Learning. Visible Learning for Literacy, Grades K-12: Implementing the Practices That Work Best to Accelerate Student Learning by Douglas B. Fisher, Nancy Frey, John A. Hattie. Published April 12 2016, Corwin Publishers.

Outcomes

A student:

* INS11/12-1 develops and evaluates questions and hypotheses for scientific investigation
* INS11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information
* INS11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* INS11/12-7 communicates scientific understanding using suitable language and terminology for a specific audience or purpose
* INS11-8 identifies that the collection of primary and secondary data initiates scientific investigations

Teaching and learning activities

Inquiry questions

For each key inquiry question, students are encouraged to design their own inquiry questions which serve to form the basis of these teaching and learning sequences.

Assessment

The strategies require students to demonstrate their learning and are all either assessment for learning or assessment as learning activities. Some activities might be selected and included in a school assessment schedule for assessment of learning.

Learning sequence

Checking prior learning

* use a pre-test, quiz, KWL, KTN, LINK chart or other graphic organiser to elucidate prior knowledge
* use a vocabulary builder to clarify words and meanings

Phase of learning: surface acquiring (organising surface knowledge)

Focus questions

* What are some common acids and bases?
* How do we test for acids and bases?

Strategy 1: Testing, organising data and recording

Students:

* use universal indicator to test acids and bases of different concentrations and compare with tap and distilled/deionised water.
* test a range of everyday substances and describe their acidity.
* investigate the effect of concentration on acidity of solutions.
* make their own indicator and assess its effectiveness as an acid/base indicator.

Strategy 2: Integrating prior knowledge

Students:

* relate the acidity of everyday substances to their uses
* list inquiry questions related to everyday substances, for example; why are cleaning products often basic? why are acids used as food additives? why are soft drinks acidic?
* identify examples of where indicators (including test strips) are used to measure acidity

Strategy 3: Highlighting

Students:

* find an article, passage or section of text which they consider describes the properties of acids and bases, and present to their group (or class).
* highlight the main ideas and words in the text
* share their understanding of the text with others

Strategy 4: Note taking

Students:

* watch a video that describes the properties of acids and bases.
* take notes in any form that describes/lists the characteristics of acids and bases, giving examples where possible.
* use think/pair/share to discuss their ideas with other students and collaboratively develop detailed notes on the characteristics of acids and bases.
* access secondary sources if needed to ensure that key words and concepts are covered.

Strategy 5: Summarising

Students:

* summarise the properties of acids and bases, using a table or chosen graphic organiser. The summary should include both quantitative and qualitative characteristics.
* share their summary with others and modify if needed.

Phase of learning: surface consolidating

Focus questions

* What are strong and weak acids and bases?
* Why are some acids (or bases) stronger than others?
* How do we test for acids and bases?
* How do we measure pH and why do we use a pH scale?
* What is the relationship between acid (or base) concentration and pH?

Strategy 1: Deliberate practice through inquiry

Students:

* pose further questions that can be investigated.
* design and conduct an investigation that addresses a chosen question.
* investigate the relationship between acid (or base) concentration and pH using an indicator or pH probe.
* conduct a practical to show the difference between strong and weak acids (or bases)

Strategy 2: Giving/Receiving Feedback

Students:

* produce a report of the investigation completed above.
* record observations and analyse the primary data collected, using tabulation, graphing and other visual representations.
* collaboratively develop, with the class, a marking rubric to be used when providing feedback to all students.
* present your report to the class, in an interesting, informative way, using at least one form of digital technology.
* provide feedback to other students on their reports using ‘Two stars and a wish”, sticky notes or the marking rubric developed.

Phase of learning: deep acquiring

Focus questions:

* What are strong and weak acids and bases?
* What is the relationship between acids and bases?
* How are acids and bases important in everyday applications?

Strategy 1: Metacognition

Students:

* use the feedback gained above to evaluate their investigation, including answers to:
  + I am happy with …… because ……
  + I could have improved ……
  + If I was doing this again, I would ……
  + The best feature of my report was …….. but I could have ……
  + I effectively …… but needed to ……
* choose one aspect of their report and show how they would change it, for example; re-tabulate, re-graph, rewrite conclusion.

Strategy 2: Elaborative interrogation

Students:

* work in pairs to develop a series of “how” and “why” questions to investigate further the properties and behaviour of acids and bases.
* choose at least one of these questions to investigate using secondary sources.
* Questions might include:
  + How has our understanding of acids and bases changed over time and with new technologies?
  + Why does acid rain form?
  + How are acids and bases important in the human body?
  + How do some substances act as both acids and bases?
  + Why do acids and bases make salts?
  + How can acids and bases be neutralised?
  + How do acids and bases react with other substances?

Phase of learning: deep consolidation

Focus questions:

What is the relationship between acids and bases?

* What is neutralisation?
* How do acids and bases interact with other substances?
* How do we safely store, handle and dispose of acids and bases?
* What role do acids and bases play in our society and the environment?

Strategy 1: Critical thinking

Students:

* use a simulation (such as from [PheT](https://phet.colorado.edu/en/simulation/acid-base-solutions)) and assess how well the simulation describes the properties of acids and bases and the concepts of pH and neutralisation https://phet.colorado.edu/en/simulation/acid-base-solutions
* investigate how your blood stays within a pH range of 7.35-7.45, what happens when your blood goes outside this range and how this problem can be corrected.
* plan and present a demonstration to illustrate the concept of neutralisation or buffering.
* evaluate the safe storage, handling, disposal and treatment of spillages of acids and bases.

Strategy 2: Collaborative/Cooperative learning

Students:

* in groups, design a worksheet, activity or interactive game that could be used to assess student understanding of acids and bases.
* identify the key concepts assessed in their activity.
* use their formative assessment strategy to assess students in a different group.
* using feedback from the trial group, evaluate the strategy used and modify for final submission.
* present their revised formative assessment strategy to the whole class.
* reflect on their own learning using 3-2-1
  + 3 things that were understood - crystals
  + 2 things that you found most beneficial to learn - thumbs up
  + 1 thing that you still don’t understand - mud

Strategy 3: Problem solving

Students:

* take on the role of detective to investigate the properties of substances provided by their teacher.
* propose three alternative solutions to a societal or environmental problem associated with acidity.

Phase of learning: transfer

Focus questions:

* What are the similarities and differences of acids and bases?

Strategy 1: Similarities and differences/comparing and contrasting

Students:

* use the information gathered in their first-hand investigations to complete a Venn diagram comparing acids and bases.
* use secondary sources to gather further details to add to their diagram.
* develop an analogy or metaphor to explain the properties and behaviour of acids and bases, to share with the class.
* write extended response questions that require students to compare and contrast acids and bases in terms of:
  + their chemical properties
  + uses in society
  + impact on the environment