



"Fire Symphony"

(Investigation of Chemical and Biological Alterations Post-Fire)

Goal of the activity

The primary objective of this activity is to comprehensively understand and analyze the intricacies of combustion using a multidisciplinary approach encompassing chemical, biological, and physical analytical techniques. Through methods such as microscopic examination of ash, pH level measurements, investigation of microorganisms present in ash samples, quantification of harmful gas concentrations, assessment of biological changes in soil and aquatic ecosystems, and statistical data analysis, the goal is to attain detailed and precise insights into the environmental impact of burning practices and to identify potential hazards and repercussions. By engaging in these analyses, students will develop advanced competencies in scientific inquiry, critical thinking, and problem-solving, enabling them to apply their knowledge effectively in real-world contexts to comprehend and safeguard the environment.

Educational Year

First and second year of secondary education

Student outcomes

Students will acquire the following benefits:

- **Enhancement of Scientific Skills:** Through activities such as microscopic exploration, chemical analyses, and measurements, students will develop their scientific skills, thereby bolstering their aptitude for scientific inquiry.
- **Comprehension of Combustion Processes:** Practical engagements will deepen students' understanding of combustion processes and their environmental ramifications, thereby refining their grasp of chemical and physical principles.
- **Refinement of Analytical Skills:** The activities integrated into this instructional module will refine students' analytical acumen, encompassing proficiency in data analysis and interpretation of findings.
- **Cultivation of Critical Thinking:** Encouraged to critically evaluate the environmental impacts of combustion and associated mitigation strategies, students will hone their critical analytical faculties.
- **Promotion of Collaboration and Teamwork:** Collaborative endeavors will facilitate peer interaction, idea exchange, and collective problem-solving, fostering an environment conducive to teamwork and cooperation.
- **Synthesis of Theory and Application:** This pedagogical approach will empower students to bridge theoretical concepts with practical applications, equipping them with the requisite skills for real-world scenarios.



Prerequisite knowledge

Prior Knowledge Requirement:

Thorough consideration of students' prior knowledge is imperative, particularly given the interdisciplinary nature of this project spanning various fields of natural sciences. To ensure effective participation, students should demonstrate proficiency in the following competencies and knowledge domains:

- **Biology:** A robust understanding of cellular and organismal structures and functions is fundamental. This encompasses an appreciation of biological diversity and the intricate interactions within soil and aquatic ecosystems, pivotal for discerning biological alterations ensuing from environmental factors.
- **Chemistry:** A foundational comprehension of chemical reactions, constituents, and principles of chemical analysis is indispensable. This knowledge is especially pertinent for tasks such as pH measurement of ash and the elucidation of chemical compositions within fire-impacted environments.
- **Physics:** A grasp of thermodynamic laws and rudimentary concepts concerning energy and heat is essential. Such understanding facilitates the comprehension of combustion processes and their physical underpinnings.
- **Mathematics:** Proficiency in basic mathematical principles, encompassing algebra and geometry, is requisite for effective data manipulation and interpretation. These skills are paramount for tasks such as gas concentration measurements and statistical analysis of empirical findings.

DESCRIPTION OF THE ACTIVITY

Activity 1: Microscopic Examination of Ash

This activity entails the meticulous examination of ash using a microscope to discern its intricate structure, thereby facilitating the comprehensive study of ash following a fire incident. As a residue of combustion, ash harbors a diverse array of materials and substances amenable to microscopic scrutiny. Within this activity, students will undertake the following procedures:

- **Sample Collection:**
 - Students will procure a sample of ash from the site of the fire incident.
 - Employing a spatula, the sample will be meticulously transferred onto a microscope slide to facilitate microscopic analysis.
- **Microscope Setup:**
 - Students will meticulously configure the microscope, ensuring optimal adjustment of objectives and lighting to procure high-fidelity imagery.
- **Microscopic Analysis:**
 - Under the microscope's scrutiny, students will scrutinize the ash's structure, focusing on discernible components.
 - They will scrutinize diverse forms and configurations of the ash, encompassing varied crystal formations, organic and inorganic materials, and other particulates.
- **Component Identification:**
 - Leveraging visual cues, students will endeavor to identify the disparate substances present within the ash.



- This entails discerning particles derived from wood, remnants of plastic, traces of metal, mineral deposits, and other discernible materials.
- Comprehending Fire Impact:
 - Through scrutinizing the ash's structure, students will attain insight into the transformative effects of fire on materials.
 - They will elucidate how distinct materials respond to elevated temperatures and combustion processes, thereby augmenting their comprehension of fire dynamics and the imperative of fire prevention.

This activity promises to furnish students with hands-on experience in microscopic analysis, fostering a nuanced appreciation of fire's ramifications on materials and the environment.

Activity 2: Measurement of Ash pH Value

The objective of this activity is to acquaint students with the procedure for measuring the pH value of ash, thereby facilitating their comprehension of the chemical transformations engendered during combustion. The measurement of ash pH is pivotal, as it affords insights into the ash's acidity or alkalinity, thereby elucidating the chemical metamorphoses precipitated by burning. Within this activity, students will undertake the following steps:

- Apparatus Setup:
 - Students will diligently assemble all requisite apparatus and materials for pH measurement, including a pH meter, universal pH indicator paper, measurement probe, and suitable laboratory receptacles.
 - Ensuring meticulous calibration, students will prepare the equipment for deployment.
- Sample Preparation:
 - Students will procure an ash sample, depositing it within a designated sample container.
 - This sample will be meticulously prepared by incorporating distilled water to yield a homogeneous mixture conducive to pH measurement.
- pH Value Measurement:
 - Submerging the pH meter probe into the ash-infused solution, students will initiate the pH value measurement process.
 - Readings will be recorded once the probe attains a stable position within the solution, yielding a consistent pH value.
- Documentation and Analysis:
 - Students will diligently document the pH value measurements.
 - Leveraging these findings, they will endeavor to discern and comprehend the repercussions of fire on the ash's pH value.
- Discussion and Conclusion:
 - Engaging in discourse, students will deliberate on the significance of pH value vis-à-vis combustion and its implications for the ash's acidic or alkaline nature.
 - They will contemplate plausible chemical reactions engendered by fire and their environmental ramifications.

This activity not only acquaints students with the chemical dynamics of combustion but also stimulates critical thinking, fostering the application of acquired knowledge in real-world scenarios to decipher the intricacies of fire processes.



Activity 3: Microscopic Analysis of Biological Changes in Soil and Aquatic Ecosystems

The objective of this activity is to acquaint students with the biological alterations manifesting in soil and aquatic ecosystems post-fire. Employing microscopic analysis, students will discern and investigate various microorganisms, biological entities, and microscopic constituents undergoing transformations following fire exposure. This activity encompasses the following steps:

- **Sample Collection:**
 - Students will procure samples from diverse environmental locales affected by the fire, encompassing soil and aquatic ecosystems such as rivers, lakes, or streams.
- **Sample Preparation for Analysis:**
 - Employing specialized techniques such as serial dilution or specimen fixation, samples from soil and water will be primed for microscopic scrutiny.
- **Microscope Utilization:**
 - Students will harness the microscope to scrutinize the samples, discerning the gamut of biological changes that have transpired.
 - They will scrutinize the presence of diverse microorganisms, bacteria, algae, alongside discernible alterations in soil structure or water composition.
- **Identification of Biological Components:**
 - Drawing upon microscopic visual cues, students will endeavor to identify the array of biological organisms and microscopic elements pervading the samples.
- **Examination of Alterations:**
 - Students will meticulously observe and analyze the alterations manifesting in biological diversity and ecosystem structure consequent to fire influence.
- **Discussion and Conclusion:**
 - Grounded in the identified alterations, students will engage in discourse elucidating the ramifications of fire on biological diversity and ecosystem functionality.
 - This activity fosters the development of analytical skills, critical thinking, and comprehension of intricate biological processes, augmenting students' understanding of fire's ecological impacts.

Activity 4: Measurement of pH Value in Water Bodies and Soil in the Vicinity of the Fire

This activity aims to introduce students to the process of gauging the pH value in water bodies and soil proximate to fire-affected areas. The determination of pH value assumes paramount significance, serving as a barometer of the acidity or alkalinity pervading these ecosystems, whilst unraveling the repercussions of fire on water and soil chemistry. The activity encompasses the following steps:

- **Apparatus Preparation:**
 - Students will meticulously assemble requisite equipment and reagents for pH measurement, inclusive of a pH meter, measurement probe, laboratory containers, and calibration solutions.
 - Calibration of equipment will be diligently executed to ensure accuracy and precision.
- **Sample Collection:**



- Students will harvest samples from water bodies (rivers, lakes, streams) and soil in locales proximate to the fire outbreak. Sampling will be undertaken across diverse locales to ensure representativeness.
- pH Value Measurement:
 - Employing the pH meter and corresponding probe, students will gauge the pH values of water and soil samples, meticulously recording results for each sampling site.
- Analysis of Findings:
 - Students will meticulously analyze measurement outcomes, juxtaposing them against established water and soil quality benchmarks.
 - Discourse will ensue concerning plausible alterations in pH values attributable to fire influence, along with potential environmental repercussions.
- Discussion and Conclusion:
 - Informed by analytical findings, students will engage in deliberation concerning the impact of fire on pH values within water bodies and soil proximal to fire-affected areas.
 - Deliberation will extend to contemplate plausible mitigation measures and ecosystem restoration initiatives.

This activity serves to elucidate the chemical dynamics underlying fire's ecological impact, whilst honing students' measurement, analysis, and interpretation skills pertinent to pH evaluation across diverse ecological milieus.

Activity 5: Statistical Analysis of Measurement Data

Statistical analysis serves as a cornerstone of the research process, facilitating objective interpretation and inference drawing from collected data. In this activity, students will undertake the following steps:

- Data Processing:
 - Students will meticulously process all amassed data from measurements, spanning pH values, concentrations of deleterious substances, microbiological alterations, and other pertinent parameters. Data will be meticulously entered into designated software or programs conducive to statistical analysis.
- Selection of Statistical Methods:
 - Tailoring their approach to the nature of data and research inquiries, students will discern and employ appropriate statistical methodologies. This may encompass statistical tests, correlation analyses, regression models, descriptive statistics, and analogous techniques.
- Interpretation of Findings:
 - Students will meticulously decipher the outcomes of statistical analysis, discerning correlations vis-à-vis research hypotheses or objectives. They will endeavor to accentuate salient findings and delineate conclusions drawn from data interrogation.
- Multifaceted Interpretation:
 - Encouraged to adopt diverse analytical lenses, students may wield distinct visual representations—ranging from graphs, diagrams, tables, to infographics—to enhance comprehension and explication of findings.



- Additionally, students may undertake qualitative analyses to augment interpretation, embedding insights gleaned from the research context or perspectives of study participants.
- Discussion and Conclusion:
 - Engaging in discursive deliberation, students will reflect upon the significance of their findings and discern their implications for the research endeavor at large. Drawing upon statistical insights, they will proffer conclusions and proactively formulate recommendations.

This activity serves as a crucible for nurturing students' proficiency in statistical analysis, honing their adeptness in interpreting scientific data, and fostering the capacity to derive cogent conclusions grounded in empirical evidence. In so doing, students acquire invaluable skills pertinent to scientific inquiry, poised for application in both natural and scientific domains.

MATERIALS

- **To facilitate the field study, an array of materials and tools will be indispensable for executing the planned activities effectively. These include:**

Materials for pH Measurement:

- pH meter equipped with a measuring probe and universal indicator paper
- Laboratory vessels for sample containment
- Distilled water to calibrate equipment
- Standard solutions for validating measurement accuracy

Microscopic Tools and Reagents:

- Microscope outfitted with varying magnifications
- Cover slips and slides for mounting specimens
- Stains and reagents for specimen visualization

Sampling Equipment:

- Pipettes for water sample extraction
- Probes for soil sample collection
- Plastic or glass containers for sample storage

Computer and Software Tools for Statistical Analysis:

- Computers furnished with requisite software for statistical data processing (e.g., SPSS, Excel, R, SAS)
- Printer for producing graphical representations of analysis results

Additional Equipment and Materials:

- Protective gear such as gloves, masks, and safety footwear
- Chemicals and reagents essential for laboratory procedures

These materials and tools are indispensable for enabling students to undertake various research activities, process data meticulously, and conduct thorough analysis. Ensuring the provision of requisite tools and equipment is imperative to safeguard student safety and guarantee the study's successful execution.

- **Lesson Sheets with Procedures and Results Recording:**

Below are sample lesson sheets outlining procedures and providing spaces for recording results. These sheets are designed to guide students through activities and experiments related to ecosystem restoration post-fire.



Laboratory Sheet: 1. Microscopic Examination of Ash

Objective of the Activity: To analyze the structure of ash samples under a microscope and record observations.

Procedure:

1. Collect a sample of ash from the designated area affected by the fire.
2. Transfer a small portion of the ash sample onto a microscope slide using a spatula.
3. Adjust the microscope settings for optimal viewing.
4. Examine the ash sample under the microscope, starting with low magnification and gradually increasing to higher magnifications.
5. Record observations of the ash structure, including any visible components, crystal formations, and organic/inorganic materials.

Results Recording:

- Sample Description:
- Magnification Level:
- Observations:

Note: Attention should be paid to the different types of materials present in the ash and how this affects the dynamics of the fire.

Laboratory Sheet: 2. Measurement of pH Value in Ash

Objective of the Activity: To measure the pH value of ash samples and analyze the chemical changes post-fire.

Procedure:

1. Prepare a sample of ash by mixing it with distilled water to create a homogeneous solution.
2. Calibrate the pH meter using standard solutions.
3. Insert the pH meter probe into the ash solution and wait for the reading to stabilize.
4. Record the pH value of the ash solution.
5. Repeat the process for multiple ash samples if necessary.

Results Recording:

- Ash Sample Description:
- pH Value:

Note: Extreme caution should be exercised when measuring the pH value, and safety protocols for handling chemicals and equipment should be followed diligently.



Laboratory Sheet: 3. Analysis of Soil and Aquatic Ecosystems Post-Fire

Objective of the Activity: To observe and record biological changes in soil and aquatic ecosystems affected by fire.

Procedure:

1. Collect soil and water samples from areas impacted by the fire.
2. Prepare microscope slides with soil and water samples.
3. Examine the samples under the microscope to identify microorganisms and biological changes.
4. Record observations of microbial diversity, structural alterations, and any other noticeable changes.

Results Recording:

- Sample Source (Soil/Water):
- Observation of Microorganisms:
- Structural Changes:

Note: Prior solid preparation for microscopic analysis is required, adhering to safety protocols and using laboratory equipment appropriately.

Laboratory Sheet: 4. Measurement of pH Value in Water Bodies and Soil in the Vicinity of the Fire

Objective of the Activity: The objective of this laboratory activity is to acquaint participants with the procedure of determining pH values in water bodies and soil proximal to fire-affected zones, elucidating the consequential alterations in the chemical composition of water and soil.

Procedure:

1. Preparation of Equipment:

- Assemble requisite apparatus and reagents essential for pH value quantification, comprising:
 - pH meter
 - pH probe
 - Laboratory containers
 - Calibration solution for pH meter
- Ensure meticulous calibration and functionality of the equipment prior to commencement.

2. Sample Collection:

- Undertake systematic sampling of water bodies (e.g., rivers, lakes, streams) and soil adjacent to fire-stricken areas.
- Employ a stratified sampling approach to ensure spatial representation and veracity of outcomes.

3. Measurement of pH Value:



- Utilize the pH meter in conjunction with the designated probe to measure pH values of collected water and soil samples.
- Methodically document the obtained pH values for each sample, ensuring accuracy and precision.

4. Analysis of Results:

- Conduct a rigorous examination of the acquired pH measurements vis-à-vis established water and soil quality benchmarks.
- Deliberate upon discernible fluctuations in pH values attributable to fire-induced influences, discerning potential ramifications for ecological integrity.

5. Discussion and Conclusions:

- Facilitate an intellectually stimulating discourse predicated upon the elicited results and their interpretative insights.
- Delve into the multifaceted repercussions of the fire's impact on the pH equilibrium of water bodies and soil substrates.
- Endeavor to proffer pragmatic strategies for the safeguarding and rehabilitation of imperiled ecosystems.

Results:

pH value of water: _____

pH value of soil: _____

Note: Prior due diligence is imperative to ensure the accurate assessment of pH values, encompassing adherence to established safety protocols and judicious utilization of laboratory instrumentation.

Lesson Plan: 5. Statistical Analysis of Measurement Data

Activity Objective: To process and analyze collected data using statistical methods.

Procedure:

1. Input collected data, including pH values, gas concentrations, and biological observations, into statistical analysis software.
2. Select appropriate statistical tests or methods based on the research questions and data characteristics.
3. Conduct statistical analysis and interpret the results.
4. Prepare visual representations of the data, such as graphs or tables.

Results Recording:

- **Statistical Test Used:**
- **Interpretation of Results:**

Note: Caution should be exercised in interpreting the results and using the analyses as a basis for discussion and conclusions.



➤ Checking the Acquired Knowledge from the Given Activity

✓ "Fire Jump" - Rapid-Fire Short Quiz

Instructions:

- This quiz consists of a series of rapid-fire questions aimed at assessing your understanding of various aspects of the project.
- Each question has a time limit of 30 seconds for your response.
- You may provide your answers either in writing or orally.
- Visual aids such as pictures or videos may be incorporated if available.

1. **Question:** What components can be identified through microscopic examination of the ash?
 - **Answer:** Microscopic examination of the ash allows for the identification of components such as minerals, organic residues, structures, and other materials remaining after the fire.
2. **Question:** What information do we obtain from measuring the pH value of the ash?
 - **Answer:** Measuring the pH value of the ash provides insights into the chemical changes occurring during the burning process and the impact of the fire on the environment, particularly regarding the acidity of the materials.
3. **Question:** What types of microorganisms can be found in the ash after the fire?
 - **Answer:** Various microorganisms, including bacteria and fungi, which may have different effects on the environment, can be found in the ash after the fire.
4. **Question:** Which harmful gases are measured in the ash as part of the research?
 - **Answer:** Harmful gases measured in the ash include CO₂, CO, SO₂, and other gases emitted during the burning process.
5. **Question:** What types of biological changes are observed in the soil and aquatic ecosystems after the fire?
 - **Answer:** Biological changes in the soil and aquatic ecosystems after the fire may include alterations in microbial diversity and other biological processes, with significant implications for the ecosystems.

✓ "Save the Ecosystem" - Engaging Game

In this interactive game, students will delve into the challenges faced by ecosystems in the aftermath of a fire. Through role-playing and problem-solving, they will devise strategies to mitigate the impact of the fire and safeguard the environment. Here's how to implement the game effectively:

1. Team Division and Roles:

- Divide participants into teams, assigning each team unique roles or characters reflective of diverse expertise, such as ecologist, plumber, civil engineer, forest ranger, veterinarian, etc.
- Encourage teams to collaborate and leverage their diverse perspectives to address the challenges ahead.

2. Scenario Development:

- Craft multiple scenarios portraying distinct challenges or problems encountered in the ecosystem post-fire. These scenarios may encompass issues like loss of biodiversity, water contamination, and threats to wildlife habitats.



- Ensure each scenario is realistic and thought-provoking, prompting teams to think critically and devise innovative solutions.

3. Development of Strategies and Solutions:

- Task teams with analyzing and resolving each scenario by formulating comprehensive strategies and actionable solutions.
- Encourage creative thinking and collaborative problem-solving as teams brainstorm ways to protect and restore the environment.

4. Presentation of Solutions:

- Provide teams with an opportunity to present their solutions to the other teams and the audience.
- Facilitate a lively debate and Q&A session following the presentations, fostering dialogue and knowledge exchange among participants.

5. Assessment and Conclusions:

- Evaluate teams' solutions based on criteria such as effectiveness, originality, and feasibility.
- Conclude the game with a reflective discussion on the importance of ecosystem conservation and the imperative of collective action to support nature's recovery to its pristine ecological state.

Through "Save the Ecosystem," students will not only deepen their understanding of environmental challenges but also cultivate teamwork, critical thinking, and problem-solving skills essential for addressing real-world ecological issues.

Prepared by

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