PROCESS SKILLS FOR LIFE SCIENCE (05)

Supervisor and Coaches Guide

prepared by Karen L. Lancour, National Supervisor

This event is a lab-oriented competition involving the fundamental science processes of a middle school life-science program. The event is not meant to be a comprehensive biology course. If specific content is needed when students are being tested on certain process skills, the supervisor will provide that content.

SCIENCE PROCESS SKILLS

The event consists of a series of biological questions or tasks that involve the use of one or more process skills. Science process skills are classified as basic skills and integrated skills. These skills can be accessed by applying them to a series of lab station activities which are included in the Guide for Supervisors, Coaches and Students. Tips to assist students in their preparations are also included in this guide.

Basic Science Process Skills:

- **Observing** - using your senses to gather information about an object or event. It is a description of what was actually perceived. This information is considered qualitative data.
- **Measuring -** using standard measures or estimations to describe specific dimensions of an object or event. This information is considered quantitative data.
- **Inferring -** formulating assumptions or possible explanations based upon observations.
- **Classifying -** grouping or ordering objects or events into categories based upon characteristics or defined criteria.
- **Predicting -** guessing the most likely outcome of a future event based upon a pattern of evidence.
- **Communicating -** using words, symbols, or graphics to describe an object, action or event.

Integrated Science Process Skills:

- **Formulating Hypotheses** - stating the proposed solutions or expected outcomes for experiments. These proposed solutions to a problem must be testable.
- **Identifying of Variables -** stating the changeable factors that can affect an experiment. It is important to change only the variable being tested and keep the rest constant. The one being manipulated is the independent variable; the one being measured to determine its response is the dependent variable; and all variables that do not change and may be potential independent variables are constants.
- **Defining Variables Operationally** - explaining how to measure a variable in an experiment.
- **Describing Relationships Between Variables -** explain relationships between variables in an experiment such as between the independent and dependant variables plus the standard of comparison.
- **Designing Investigations** - designing an experiment by identifying materials and describing appropriate steps in a procedure to test a hypothesis.
- **Experimenting -** carrying out an experiment by carefully following directions of the procedure so the results can be verified by repeating the procedure several times.
- **Acquiring Data -** collecting qualitative and quantitative data as observations and measurements.
- **Organizing Data in Tables and Graphs -** making data tables and graphs for data collected.
- **Analyzing Investigations and Their Data -** interpreting data statistically, identifying human mistakes and experimental errors, evaluating the hypothesis, formulating conclusions, and recommending further testing where necessary.
- **Understanding Cause and Effect Relationships** - what caused what to happen and why.
- **Formulating Models** - recognizing patterns in data and making comparisons to familiar objects or ideas.

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GUIDE FOR SUPERVISORS, COACHES, & STUDENTS

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Lab Stations and Tasks for Assessing Process Skills

Below is a list of lab stations and types of questions or tasks which might be used to assess science process skills. To allow most students to be successful, it may be a good idea for event supervisors to vary the difficulty of questions at each station!

Lab Safety

- Distinguishing "safe" behaviors vs. "unsafe" behaviors, identifying safety symbols, evaluating situations -- what to do "if" or what's wrong.
- Identifying the proper techniques to handle lab emergencies.

Observations

- Using senses to notice specific features.
- Identifying similarities and differences in features.
- Identifying qualitative and quantitative changes in conditions.
- Using observable properties to classify objects, organisms or events.

Inferences

- Formulating assumptions based upon observations.
- Distinguishing between observations and inferences.
- Using observations and inferences to identify testable questions or problems.

Problem

- Using observations to propose a topic for experimentation.
- Narrowing the scope of the topic to specific testable aspects.
- Formulate problems within the specific aspects of the topic which are clearly testable.
- Identify which of the problems can be tested with materials available.
- Generalizing variables to be considered in testing the problem such as “The effect of (the independent variable) upon (the dependent variable.)

Hypothesis

- Proposing a hypothesis for a given problem.
- Predicting the effect of the change in the independent variable upon the dependent variable.
- Explaining the relationship or tend that is expected to occur.
- Providing rationale for a hypothesis or prediction.
- Determining the testability of a hypothesis based upon materials provided.
- Evaluating statements presented with a set of data as to their appropriate label.: **1**. logical hypothesis, **2**. illogical hypothesis of contrary to data, **3**. not a hypothesis, but a restatement of data, **4**. reasonable hypothesis, but not based on data

Predictions

- Predicting the results for a proposed lab test or setup.
- Selecting predictions based upon previously observed patterns.
- Providing rationale for predictions.

Lab Equipment

- Identifying pieces of lab equipment and their function.
- Identifying appropriate pieces of equipment to perform a specific task.
- Selecting and using the appropriate piece(s) of lab equipment for a task.

Procedures

- Analyzing procedures for flaws in design.
- Identifying the proper set of equipment for carrying out an experimental procedure.
- Arranging steps of procedures in the appropriate order.
- Determining the repeatability of a procedure.
- Identifying an appropriate procedure to test a problem.

Design Analysis

- Analyzing designs for experiments relative to problem,
- Evaluating the basic assumptions used in the design of the experiment.
- Identifying components as the independent variable, dependent variable, constants (controlled variables), standard of comparison (control), and time period for the test.
- Evaluating the procedure for repeatability.
- Evaluating the materials and appropriateness of the steps in the procedure.
- Identifying appropriate types of qualitative and quantitative data to be collected.

Measurement

- Identifying the capacity, range, and increments of measuring devices as a ruler, graduated protractor, caliper, cylinder, pipet, syringe, or thermometer.
- Identifying length, temperature, volume, and mass to the capacity of the instrument.
- Converting units within the metric system.
- Reading the meniscus when measuring liquids in a cylinder.

Balances

- Identifying types of balances as electronic and triple beam.
- Determining the capacity of the balance, its increments, its readability, the types of auxiliary weights, the parts of the balance and their function.
- Determining the mass of an object to the capacity of the instrument.
- Using auxiliary weights to reach the capacity of a triple beam balance.

Microscopy

- Understanding of parts of microscope & their function, magnification, appearance of images, resolution, changes in field with magnification, types of microscopes and their uses.
- Preparing a wet mount.
- Using a light microscope to perform a requested task.
- Using a dissecting microscope to perform a requested task.

Chemical Analysis

- Identifying the appropriate reagents for specific chemical testing.
- Using reagents as pH paper, iodine, glucose test paper, bromthymol blue for chemical analysis.
- Interpreting the results of reagent data.

Dichotomous Key

- Using observations to formulate a dichotomous/taxonomic key.
- Identifying individuals or objects using a dichotomous key.
- Identifying similarities and differences in characteristics from a dichotomous key.

Calculations

- Using measurements to determine area, volume, percentages, probabilities, ratios.
- Determine population density of a sample.

- Performing statistical analysis of raw data as mean, median, mode, and range.

Data Presentation

- Preparing an appropriate date table, chart, diagram, illustration.
- Evaluating the presentation of data**.**

Graphing

- Selecting the appropriate graph for a set of data as line, bar, and pie graphs.
- Identifying the title, source, independent variable & dependent variables, and the legend.
- Scaling each axis for a graph.
- Preparing a line, bar or pie graph to represent a set of data.
- Predicting data points not included in a given graph and/or making a best line fit.
- Interpreting a graph and making predictions or inferences based upon the data on a graph.

Analysis of Data

- Identifying sources of experimental error or human mistakes in the data.
- Determining the validity of results using qualitative and quantitative data.
- Interpreting graphs as well as charts and diagrams as food webs, pedigrees, Punnett squares, food labels, energy and food pyramids, relationships of organisms.
- Identifying data which supports or rejects a hypothesis.
- Identifying discrepancies between stated hypothesis and actual data.
- Understanding cause and effect relationships.

Errors

- Identifying human mistakes or blunders.
- Identifying experimental errors as systematic errors and random errors.
- Making recommendations for eliminating future mistakes or experimental errors.
- Explaining the effects that human mistakes or experimental errors upon results.

Conclusions

- Selecting the most logical conclusion for given experimental data.
- Accepting or rejecting hypotheses based upon data analysis.
- Proposing a new hypothesis for rejected hypotheses.
- Formulating models
- Proposing a future test for inconclusive results.

Some Helpful Hints for Event Supervisors*:*

- It may help to have questions laminated or placed in sheet protectors. This procedure eliminates damage or tampering during competition.
- Taping questions to the table helps to keep stations organized and undisturbed.
- Bring extra items needed at stations as extra rulers.

Quick supervisor checklist of useful items to include

stop watches, answer sheets, extra set of questions, tie-breaker sheets, answer keys, highlighter, calculator, extra pencils, red pens, extra mm rulers, stapler, masking tape, scotch tape.

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I hope these suggestions are helpful in organizing your tournament. Comments or new ideas are always welcome.

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There is a training manual entitled Coaches Handbook for Life Science Process Lab available from the Science Olympiad National Office. It contains lessons for use in the classroom and with your team as well as three sample tournaments.

There are also training manuals for other events and video tapes for many building events. The order form for all training guides and video tapes is available at http://soinc.org/tguides.htm