Paideia Seminar Lesson Plan

**Text:**

Scientific Method (11 steps or stages) by Norman Edmund

**Grade/Subject:**

MS / Science

**Ideas, Values:**

Cause, Deduction, Hypothesis, Inductive, Inquiry, Reasoning

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**Pre-Seminar Content**

**Launch Activity:**

This seminar can be situated in any science class or any curricular area dealing with epistemology. Ponder with students how we know what we know. Pose the question: How do you know something? Students jot down responses before sharing whole group. Note patterns or recurring ideas.

**Background Information:**

Norman Edmund (1916-2012) was the founder of Edmund Optics. His work in photography led him into a lifelong pursuit of considering the creative characteristics necessary for being scientific — including the use of a universal scientific method. He managed, and was the prime contributor, to the website www.scientificmethod.com.
Inspectional Read:
Distribute the text and ask participants to anticipate what they expect this reading to be like. Be sure that participants note the numbering of steps/stages in addition to numbering the pages. Participants should also consider the use of headings and font variations as contextual clues for organization. Read the text aloud together.

Vocabulary:
Provide (or mine participants for) definitions for Context/Rare Words: inductive, tentative, analytical, judicial, contending, ecological effects.

Analytical Read:
(Post directions.) Ask participants to read the text a second time on their own and underline/highlight what they consider to be the most significant point in each step/stage. Students annotate by taking notes in pairs in the margin for each step/stage: (P) Paraphrase briefly the most important information/idea from that step; and (W) Why I think that. (Allow ample time, and model annotating the first step of the eleven with students.)

Pre-Seminar Process
Define and state purpose for Paideia Seminar.
Describe the responsibilities of facilitator and participants.
Have participants set a Personal Goal.
Agree on a Group Goal.
Seminar Questions

Opening (Identify main ideas from the text.):

- Without providing an explanation, name an idea or life-lesson you think is found within the text. (round-robin response) (Facilitator listens closely as students share and records them.)
  Now listen to the list we have generated (read list). Try explaining an idea heard that was not initially yours.

Core (Analyze textual details.):

- How is this similar to and/or different from other “Scientific Method” texts you have seen?
- Full-on experimentation does not seem to happen until the 8th step/stage. Why might that be?
- What steps/stages seem most strongly linked together? Explain your thinking.
- What step might most challenge a middle-school student? What needs to happen in order to meet that challenge?
- What step do you think represents the biggest learning opportunity? Explain.
- Where are the strongest examples of creativity in the method? Where is logical thinking necessary? Is there a place where they seem intertwined?

Closing (Personalize and apply the ideas.):

- What steps/stages seem most universally applicable — what stages/steps could you use in parts of your life beyond science class?
Post-Seminar Process

- Have participants do a written self-assessment of their personal participation goal.
- Do a group assessment of the social and intellectual goals of seminar.
- Note reminders for next seminar.

Post-Seminar Content

Transition to Writing:

(The facilitator will anchor the transition to writing by repeating the last core question once students are situated in their normal seating arrangement for writing. See Brainstorm below.)

Writing Task:

After reading and discussing this “alternate” version of the Scientific Method, write an opinion column for an imaginary science website magazine in which you evaluate if the scientific method is more about creativity or logical thinking or both. Support your position with evidence from the text, and possibly other versions of the scientific method. Consider your audience to be science teachers interested in a middle school student’s point of view on teaching science. (Argumentation/Comparison)
**Brainstorm:**

Participants will brainstorm further, first independently and then as a group, the last core question:

Where are the strongest examples of creativity in the method? Where is logical thinking necessary? Is there a place where they seem intertwined?

Initially, the teacher should lead this whole group as students are writing to generate ideas. (May also be done independently before seminar as a pre-write.)

**Structure the Writing:**

Allot a few minutes for all to revisit the text, draft an outline for their writing, and refine their thinking. Have students use an organizational template as needed.

**First Draft:**

Challenge all to draft their essays by writing the paragraphs defined by their outlines. Refer to the original definition in order to illustrate key points. Encourage a text reference for each point.

**Collaborative Revision:**

Have participants work in pairs to read their first drafts aloud to each other with emphasis on reader as creator and editor. The reader should make a special note to signify to the listener the connection between his/her point and the corresponding support selected from the text. The listener says back one point heard clearly, how it is supported by the text, and asks one question for clarification. Roles are then switched. Give time for full revisions resulting in a second draft.

**Edit:**

Once the second draft is complete, have participants work in groups of three-four and this time take turns reading each other’s second drafts slowly and silently, marking spelling or grammar errors they find, with a limit of 5 per page. (Have dictionaries and grammar handbooks available for reference.) Take this opportunity to clarify/reteach any specific grammar strategies you have identified that your students need. Give time for full revisions and editing, resulting in a third and final draft.
Publish:

Publish (either virtually or on paper) the final copies of the resulting personal essays in a collection to be shared via the class web site and as exemplary personal essays for future students. These pieces may serve as a great way for the school community to see and talk about the creative aspects necessary (and to be celebrated) in those that do science!

This Paideia Lesson Plan was created by:

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Organization:

    National Paideia Center
Scientific Method (11 steps or stages) by Norman Edmund

1st STEP OR STAGE of the Scientific Method
CURIOSOUS OBSERVATION

Scientific Method Observation
Curious observation is the start of the inductive process. Discovery of new problems, ideas, theories, decisions needed, and problem prevention usually begin with curious observation using the five senses: smelling, tasting, hearing, feeling, seeing. Instruments and tools can be used to help extend these senses. Use your sense perceptions and projections visually and mentally. Turn thoughts over and over in your mind. Use reasoning, your imagination, and introspection. Being in the right mood, motivated, and sensitive helps! Train your mind to interpret what you see. Learn to be a problem solver.

2nd STEP OR STAGE
IS THERE A PROBLEM?

Scientific Method Problems as Questions:
Look at Problems as Challenges and Opportunities
An idea, problem, decision or tentative theory should be presented in the form of a question because:
- It encourages you to keep an open mind, and thus seek the "truth."
- A question is a tool and a guide for productive thinking about a problem.
- A problem is often successfully reformed.

3rd STEP OR STAGE
GOALS & PLANNING

Using the Scientific Method Requires...
GOALS—End results you want to achieve in solving a problem:
- Goals must be realistic, flexible, and subject to change.
- Put goals in writing. This helps analyze priorities and avoid carelessness.
- Consider methods, processes, technologies, systems, strategies, and formulas needed.
- Set target dates for stages and completion.
- Learn to process information efficiently.

PLANNING—How to reach your goals:
- Planning speeds solutions and avoids wasted time and effort. Put plans in writing.
- Develop a plan to use today's huge computer databases of information.
- Abstract and Outline: theories, concepts and basic principles involved in the problem.
- Consider breaking down into sub-problems; each may require a plan.
- Plan must be flexible. When working on complex, ill-structured problems, things will change frequently.
4th STEP OR STAGE
SEARCH, EXPLORE, & GATHER THE EVIDENCE

This step or stage is the heart of problem solving and contributes to the importance of the scientific method. You start to search everywhere, explore all angles, leads, clues, and sources of information. Pick out the basic principles of the material you read, see, or hear. Gather all the evidence that will help you solve the problem, always trying to use innovation and creativity, thus building your list of possible tentative solutions.

5th STEP OR STAGE
GENERATE LOGICAL & CREATIVE ALTERNATIVE SOLUTIONS

Logic & the Scientific Method
Logical Solutions (or Trial and Error)
You can solve many problems the same way many great discoveries have been made—by trial and error or by using gradual, systematic, steady, analytical, and judicial reasoning and logic. You gather the data and fit it together. What was a puzzle falls into a logical order. Aha! You now have a discovery or solution to your problem. Most importantly, however, problems are solved by the leap of the imagination, as often the solutions are infinite.

6th STEP OR STAGE
EVALUATE THE EVIDENCE

Using the Scientific Method
By now you should have a list of tentative solutions that are candidates for your educated guess or hypothesis. This is also the step or stage for experimenting and testing. The final choice is often called your working hypothesis and will be your 7th Step or Stage.

7th STEP OR STAGE
MAKE THE EDUCATED GUESS (HYPOTHESIS)

Scientific Method Hypothesis
Your educated guess, technically The Hypothesis, is a proposed solution to the most recent definition of your problem. It is your choice of the most-likely-to-be-successful solution from the list of contending ones that you have evaluated.

8th STEP OR STAGE
CHALLENGE THE HYPOTHESIS

Experimenting, Testing, & Challenging the Hypothesis
The degree of challenge to your hypothesis will depend on the type of problem and its importance.
It can range from just seeking "a good enough" solution (but not a haphazard or lazy one) to a much more rigorous challenge.

9th STEP OR STAGE
REACH A CONCLUSION

Scientific Method Conclusion
You have challenged your working hypothesis. Now comes the conclusion when using the scientific method. If your scientific method hypothesis is partially wrong, you backtrack, modify, and then challenge again. If completely wrong, you backtrack and take another path. We learn from our failures. If your hypothesis passes the important tests, including attempts to falsify, you have reached your conclusion!

Scientific Method Review—Your Conclusion Should Be (among other things):
▪ broad enough to fit all acceptable data;
▪ limited enough to meet special exceptions;
▪ consistent when tested by you (and others) again and again;
▪ seldom extended beyond the evidence;
▪ suitable to base a report on, if one is scheduled; and
▪ an answer to the problem, as you has finally defined it.

10th STEP OR STAGE
SUSPEND JUDGMENT

Throughout a project, a good researcher has an open mind and a skeptical, but practical, attitude, always suspending judgment to some degree. He or she is mentally prepared to be wrong. You have spent a lot of time and effort applying the scientific method to reach a final scientific method conclusion—do not "fall in love" with your final hypothesis. Watch for other concepts or trains of thought.

11th STEP OR STAGE
TAKE ACTION

This is often called the "gaining acceptance" stage.
▪ Review your plans and goals. Have the courage to act now.
▪ Innovation and creativity can help immensely. Read how to present, sell, and gain acceptance of your concluding hypothesis. Get other opinions.
▪ Give proper credit to your team, reference sources, and associates.
▪ Report the social and ecological effects of your hypothesis.