

**ADE/B.Ed. (Hons.) Elementary
Syllabus
Science 1 (General Science)
Semester 1**

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Technical Support: Education Development Centre (EDC); Teachers College, Columbia University

Syllabus: Science I

YEAR/SEMESTER: Year 1 / Semester 1
DURATION (Hours): 48 hours (16 weeks)
CREDIT VALUE: 03 credits
PREREQUISITES: Matriculation (with a science subject)

COURSE DESCRIPTION

This Science I course will refresh and strengthen prospective teachers' subject matter knowledge. It lays a foundation for the pedagogical content knowledge also required to effectively teach general science in elementary school. The course covers core concepts in physical science, life science, and earth science. Also covered are the teaching strategies and instructional approaches that best support the development of conceptual understanding of science.

Science I in Semester 1 is followed by Science II in Semester 3. Both courses integrate science content with science pedagogy and skill building instead of teaching them separately. Both content outcomes and process outcomes have been listed. This division in the objectives between content and process is primarily one of convenience. It allows outcomes to be adequately represented in a written document. In the classroom, content and process should always be addressed simultaneously. After completing Science I and Science II, the prospective student teachers will be well prepared to implement the National Curriculum in elementary grades 1-5.

The Science I and Science II course materials are designed to prepare prospective elementary teachers to teach inquiry science in grades 1-5. The (pedagogical) content knowledge is chosen accordingly. Prospective science teachers who want to teach science in higher elementary grades (6-8) should deepen their science knowledge further by attending additional science classes offered in Year 3 and Year 4 of the B.Ed. (Hons) program.

COURSE OUTCOMES:

After completing this course, student teachers will be able to:

1. Describe the interdependence of ecosystems and the organisms within and how changes affect populations and the equilibrium of a system. Relate evolutionary forces to the diversity of ecosystems and of the species within them.
2. Identify the effects of human activities and naturally occurring changes on ecosystems and the consequences of those changes.
3. Begin to see the Earth as a system consisting of major interacting components that consistently undergo change. Physical, chemical, and biological processes act within and among them on a wide range of timescales.
4. Describe physical and chemical properties and physical/chemical processes with a special focus on the change of state of matter and how this change relates to energy.
5. Develop an understanding of common misconceptions about matter and particle theory.
6. Be able to describe a chemical reaction in the context of a rearrangement of atoms and also in the context of the formation of a new substance with new properties.
7. Investigate the relationships among force, mass, and motion of an object or system.
8. Be able to apply various models to science teaching while recognizing their limitations. Prevent potential misconceptions that could result from the use of some widely used models.
9. Be able to read, record, and analyze data, and present that data in meaningful ways.

Teaching-Learning Framework

Throughout this course, pedagogy is interwoven with the content development. Faculty will model inquiry teaching to student teachers in order for them to experience firsthand the learning and teaching of science in an inquiry way. Thoughtful discussions will follow such hands-on experiences to clarify the applied methods and expected learning. These reflections are essential because it is through these discussions that prospective teachers will gain essential pedagogical content knowledge. They will also learn how to apply this knowledge to their science teaching in elementary grades upon graduation. Discussions, reflections, and application of pedagogical science content knowledge are critical components of Science I (and Science II). Each task prepares prospective teachers for their own teaching and enables them to modify activities to best meet the needs of their individual classrooms. For this reason, a substantial amount of time is dedicated to the “Teaching of Specific Science Content” in each unit of the course.

In addition to content and pedagogical content knowledge, this course is also designed to help students develop science thinking and process skills.

After completing this course, student teachers will be able to:

1. Begin to apply inquiry to the teaching of science at the elementary level.
2. Be able to identify, adapt, and modify investigations that lead to conceptual understanding.
3. Begin to design science investigations around core concepts.
4. Begin to understand the need for learning progressions.
5. Recognize common misconceptions and be able to respond with appropriate remediation.
6. Be able to use open-ended questions to assess students’ conceptual understanding.
7. Provide their students with exciting science experiences that extend their natural fascination with the world and help them learn the science skills and concepts they will need in later schooling and in life.
8. Reflect on their teaching to develop a personal approach to the teaching of science.

SEMESTER OUTLINE

Unit 1: Course Overview

Week	Topics/Themes
1	Course overview Science in personal and social perspective The nature of science and scientific investigation (observations, inferences) Teaching of science: reflect upon the way prospective teachers learned science and how they want to teach science when they graduate.

During this unit, prospective teachers will:

- Discuss the nature of science and contrast science to other ways of knowing about the world.
- Understand the differences between results, conclusions, and inferences.
- Describe how science is a process rather than a product.
- Provide examples for the impact of science in daily life and the environment.

Unit 2: Populations and Ecosystems

Week	Topics/Themes
2	Basic needs of living things Interdependencies of living things (symbiotic relationships)
3	Ecosystems and Habitats Population Growth – Survival and Extinction
4	Teaching “Populations and Ecosystems” in elementary grades

During this unit, prospective teachers will:

- Investigate the interdependence of living things (including humans) in an ecosystem.
- Investigate how changes in environments affect plants and animals (including humans).
- Explain how adaptive characteristics of a species affect its chance for survival or possible extinction.
- Describe factors that limit or support the growth of populations within an ecosystem.
- Analyze data collected over time, and explain how disruption in one part of an ecosystem can repeat throughout an ecosystem.
- Begin to identify the unit’s underlying core science concepts for elementary students.
- Design age-appropriate, inquiry-based activities and identify learning outcomes.

Unit 3: Diversity and Adaptations

Week	Topics/Themes
5	Diversity of living things Systems of classification
6	Adaptations for survival Evolution and Diversity
7	Teaching “Diversity and Adaptations” in elementary grades

During this unit, prospective teachers will:

- Describe the diversity of living things.
- Explain how adaptive characteristics of a species affect its chance for survival or possible extinction.
- Explain how evolution has resulted in diversity among living things.
- Observe fossil records and interpret them for evidence of adaptation, environmental change, and extinction.
- Explain why we use classification systems and how classification systems are applied.
- Begin to identify the unit’s underlying core science concepts for elementary students.
- Design age-appropriate, inquiry-based activities and identify learning outcomes.

Unit 4: Earth – The Blue Planet

Week	Topics/Themes
8	Earth - an inhabitable planet Weather and Seasons Categorizing the world by continents, biomes, vegetation zones, climate zones, etc. Introduction to maps; reading and creating simple data charts
9	Constant changes on Earth – rock cycle Rivers (erosion / sedimentation) Earthquakes and Volcanoes
10	Teaching “Earth – The Blue Planet” in elementary grades

During this unit, prospective teachers will:

- Recognize that the abundance of water on Earth makes Earth unique and habitable.
- Describe and give examples of ways in which Earth’s surface is built up and torn down by natural processes.
- Explain how weathering and erosion reshape landforms by eroding rock and soil in some areas and depositing them in others.
- Investigate landforms and identify constructive and destructive forces that led to their formation.
- Begin to identify the unit’s underlying core science concepts for elementary students.
- Design age-appropriate, inquiry-based activities and identify learning outcomes.

Unit 5: Force and Motion

Week	Topics/Themes
11	Relationship among force, mass, and motion of an object. Interaction of objects as it relates to force and linear, constant motion. Graphing of motion and basic calculations of speed and average speed.
12	Non-linear motion and accelerated motion. (Laws of motion) Graphing of non-linear and accelerated motion.
13	Teaching “Force and Motion” in elementary grades

During this unit, prospective teachers will:

- Articulate and demonstrate the principles of motion and forces, and apply them to examples of interactions between objects.
- Investigate the relationships among force, mass, and motion of an object or system.
- Conduct investigations to determine the position and direction of a moving object (and represent its motion on a graph).
- Draw free-body diagrams that list all the forces acting on an object and the resulting direction of motion.

- Analyze the motion of objects by the established relationships known as the laws of motion.
- Begin to identify the unit's underlying core science concepts for elementary students.
- Design age-appropriate, inquiry-based activities and identify learning outcomes.

Unit 6: Properties and Matter

Week	Topics/Themes
14	Physical properties of matter, including melting point, boiling point, hardness, density, and conductivity Atoms, molecules, mixtures, elements, and compounds Introduction to the periodic table
15	States of matter: solid, liquid, gas (examples of water) Introduction to models and their limitations in science teaching
16	Teaching “Properties of Matter” in elementary grades

During this unit, prospective teachers will:

- Differentiate between physical and chemical properties of matter.
- Classify chemicals as pure substances or mixtures (homogenous or heterogeneous) and classify pure substances as elements or compounds.
- Identify atoms and molecules as the building blocks of elements, compounds, and mixtures.
- Explain the atomic structure, addressing parts and properties of the atom.
- Analyze the relationship between the structure and the properties of matter, focusing on chemical properties of elements and their placement in the periodic table.
- Explain how substances change from one state to another by heating or cooling.
- Describe a model of the atom and what it depicts as well as its limitations.
- Begin explaining student misconceptions about properties and particle theory, and what to do about them.
- Begin identifying the underlying core science concepts in this unit for elementary students
- Design age-appropriate, inquiry-based activities and identify learning outcomes.
- Begin developing learning progressions.

SUGGESTED TEXTBOOKS AND REFERENCES

There are many science books and other reference that could be useful during this course. Here is just a selection:

Target Science - Physics by Stephen Pople

Target Science - Chemistry by Michael Clugston & Rosalind Fleming

The Teaching of Science in Primary schools – Wynne Harlen

Inquiry – Thoughts, Views, and Strategies for the K-5 Classroom – National Science Foundation

Ready, Set, Science! Putting Research to Work in K-8 Science Classrooms – National Research Council

Taking Science to School: Learning and Teaching Science in Grades K-8 – National Research Council

Lederman, N. & Abd-El-Khalick, F. (not dated). “Avoiding De-Natured Science: Activities That Promote Understandings of the Nature of Science” retrieved from http://toolbox.learningfocused.com/data/0000/0014/2125/Teaching_the_NatOSci.pdf.

“A science prototype: Rutherford and the atom,” (not dated) retrieved from <http://undsci.berkeley.edu/lessons/pdfs/rutherford.pdf>.

Understanding Science is a website that communicates what science is and how it works: <http://undsci.berkeley.edu/index.php>.

For an easy to understand illustration of Newton’s Laws of Motion, go to <http://teachertech.rice.edu/Participants/louviere/Newton/>.

For information about Bloom’s Taxonomy, refer to http://www.odu.edu/educ/roverbau/Bloom/blooms_taxonomy.htm.

COURSE ASSIGNMENTS

Suggested assignments are included in the Unit Guides of the course. Some are short-term assignments and some take several weeks to complete. A mix of individual and group assignments is also provided.

These assignments are designed to deepen students’ learning and allow them to research and apply their knowledge to topics of personal interest. All the assignments count toward the final grade.

Examples of assignments include:

- a) Conduct an investigation on a science topic and present your findings and conclusions.
- b) Develop hands-on activities around a core science concept for an elementary grade.
- c) Write an editorial for a local newspaper on a relevant science topic stating an opinion supported by evidence.
- d) Plan and conduct a science activity with a group of children using the inquiry approach.

GRADING POLICY

The university and its affiliated colleges will determine the course grading policy. The policy should be shared with students at the beginning of the course. It is recommended that at least 50% of the final grade is determined by course work completed by prospective teachers. Course work may include work completed in assignments in or outside the classroom, or assignments at school.