Appendix #1A - General Science Elementary Major Requirements

KEENE STATE COLLEGE
BACHELOR OF ARTS/SCIENCE
GENERAL SCIENCE ELEMENTARY CERTIFICATION

It is the student's responsibility to follow the **official** requirements of his/her degree, which are found in the Keene State College catalog. This planning sheet is for advising purposes.

Name: _____ Student I.D.#: _____

Institution(s) Attended: _____ Credits: _____

_____ Update: _____ =

I. GENERAL EDUCATION 42 credits

A. English Language Competence: ENG 101 is required of all students.

ENG 101: _____ ____ ____

B. Arts & Humanities: A minimum of five courses totaling at least 15 credits as follows:

One course in Literature _____ ____ ____
{Any English course other than ENG 101, 202, 203, 204, 205, 301, 302, 303, 310, 311, 382. FR 340 or FR, GER, or SP 498 (when topics focus on French, German or Spanish literature)}

ART _____ ____ ____ MU _____ ____ ____

US HIST _____ ____ ____

One course from Arts & Humanities disciplines: AMST, ART, COMM, ENG, FILM, FR, GER, HIST, IDAH, JRN, ML, MU, PHIL, SP, or TAD

_____ ____ ____ _____ ____ ____

C. Social Sciences: A minimum of four courses totaling at least 12 credits in three or more of the Social Science disciplines: ECON, GEOG, POSC, PSYC, SOC or an approved interdisciplinary course (designated IDSS)

GEOG 204 Physical Geography ____ ____ _____ ____ ____

_____ ____ ____ _____ ____ ____

D. Sciences/Math: A minimum of four courses totaling at least 12 credits as follows:

MATH 171 Structure of Number ____ ____ MATH 172 Application of Number Systems ____ ____

MATH 120 ***or*** 130 ***or*** 151 ____ ____

The remaining Science requirements are fulfilled by core requirements.

II. MAJOR REQUIREMENTS

(1) Science Core (*34 credits*)

ASTR 307 University Astronomy *or*	**_3_**
ASTR 101 Elementary Astronomy	
BIO 151/152 Life: Diversity & Lab	**_4_**
BIO 153/154 Life: Processes & Lab	**_4_**
BIO 252 Ecology & Evolution	**_3_**
CHEM 132 Survey of Chemistry;	**_4_**
CHEM 136 Exp. Survey of Chemistry	
GEOL 201 Intro to Physical Geology	**_4_**
MET 225 Meteorology	**_3_**
PHYS 201 Phenomenal Science	**_3_**
IDSM 301/302 The Web of Science I, II	**_6_**

(2) Education Core *(40 credits)*

ESEC 100 Intro to Teaching	**_1_**
ESEC 150 Dev., Except., Learning I	**_3_**
ESEC 250 Dev., Except., Learning II	**_3_**
ESEC 281 Emerging/Evolving Literacy	**_3_**
ESEC 320 Ed. Environ. and Practices	**_3_**
ESEC 382 Methods: Primary	**_3_**
ESEC 383 Methods: Intermediate	**_3_**
ESEC 386 Methods: Field Experience	**_3_**
ESEC 387 Creating Social Contexts for Learning	**_3_**
ESEC 450 Seminar: Ed. Principles	**_3_**
ESEC 460 Student Teaching	**12_**

Optional Science Minor (in addition to above Science requirements)

Biology [13 cr]:

***One* of the following three lecture courses:**
- **BIO 251 Genetics (3)**
- **BIO 253 Physiology of Plants and Animals (3)**
- **BIO 254 Cell Biology (3)**

and

***One* of the following three laboratory courses:**
- **BIO 255 Experimental Genetics (2)**
- **BIO 256 Ecology and Evolution Lab (2)**
- **BIO 257 Experimental Physiology (2)**

Electives
- **8 Biology credits at the 300 level or higher**

Geology [16 cr minimum]: **GEOL 202 plus 4 additional courses at 300 level or above selected under advisement of Geology faculty and major advisor**

III. ELECTIVES

Select additional courses to reach a total of 120 credits for the degree.

If you wish to use transferred courses toward major/minor requirements, you must use the course substitution process. Contact the Academic Advising Center for more information.

It is highly recommended to begin planning your course schedules very early in your college career. Plot out your courses, semester by semester, especially in conjunction with an advisor.

Appendix #1B - General Science Middle School Major Requirements

KEENE STATE COLLEGE
BACHELOR OF ARTS/SCIENCE
GENERAL SCIENCE MIDDLE SCHOOL CERTIFICATION

It is the student's responsibility to follow the **official** requirements of his/her degree, which are found in the Keene State College catalog. This planning sheet is for advising purposes.

Name: _____ Student I.D.#: _____

Institution(s) Attended: _____ Credits: _____

_____ Update: _____ =

I. GENERAL EDUCATION 42 credits

A. English Language Competence: ENG 101 is required of all students.

ENG 101: _____ ____ ____

B. Arts & Humanities: A minimum of five courses totaling at least 15 credits as follows:

One course in Literature _____ ____ ____
{Any English course other than ENG 101, 202, 203, 204, 205, 301, 302, 303, 310, 311, 382. FR 340 or FR, GER, or SP 498 (when topics focus on French, German or Spanish literature)}

US HIST _____ ____ ____ ART, COMM, FILM, MU, or TAD ____ ____

Two courses from Arts & Humanities disciplines: AMST, ART, COMM, ENG, FILM, FR, GER, HIST, IDAH, JRN, ML, MU, PHIL, SP, or TAD or an approved interdisciplinary course (designated IDAH)

_____ ____ ____ _____ ____ ____

C. Social Sciences: A minimum of four courses totaling at least 12 credits in three or more of the Social Science disciplines: ECON, GEOG, POSC, PSYC, SOC or an approved interdisciplinary course (designated IDSS)

GEOG 204 Physical Geography ____ ____ _____ ____ ____

_____ ____ ____ _____ ____ ____

D. Sciences/Math: A minimum of four courses totaling at least 12 credits as follows:

MATH 120 ***or*** 130 ***or*** 151 ____ ____

The remaining Science requirements are fulfilled by core requirements.

II. MAJOR REQUIREMENTS

(1) Science Core (*35 credits*)

ASTR 307 University Astronomy *or*	**_3_**
ASTR 101 Elementary Astronomy	
BIO 151/152 Life: Diversity & Lab	**_4_**
BIO 153/154 Life: Processes & Lab	**_4_**
BIO 252 Ecology & Evolution	**_3_**
CHEM 111/115 Gen Chem I/Exp Gen Chem I	**_4_**
CHEM 112/116 Gen Chem II/Exp Gen Chem II	**_4_**
GEOL 201 Intro to Physical Geology	**_4_**
MET 225 Meteorology	**_3_**
PHYS 201 Phenomenal Science	**_3_**
PHYS 210 History of Science	**_3_**

(2) Education Core *(37 credits)*

ESEC 100 Intro to Teaching	**_1_**
ESEC 150 Dev., Except., Learning I	**_3_**
ESEC 250 Dev., Except., Learning II	**_3_**
ESEC 282 Literacy in Content Areas	**_3_**
ESEC 320 Ed. Environ. and Practices	**_3_**
ESEC 384 Methods: Middle School	**_3_**
ESEC 386 Methods: Field Experience	**_3_**
ESEC 387 Creating Social Contexts for Learning	**_3_**
ESEC 450 Seminar: Ed. Principles	**_3_**
ESEC 460 Student Teaching	**12_**

In addition to the science core, <u>either</u> a specialization <u>or</u> a science minor must be completed:

(a) SPECIALIZATION: plus three or more additional courses at the 200 level or above in one of the following areas: Biology, Chemistry, or Geology _9_

(b) SCIENCE MINOR: a minor in one of the basic fields of Biology, Chemistry, or Geology consists of the core courses plus additional courses noted below in the field of your choice.

Biology [13 cr]: ***One* of the following three lecture courses:**
- **BIO 251 Genetics (3)**
- **BIO 253 Physiology of Plants and Animals (3)**
- **BIO 254 Cell Biology (3)**

and

***One* of the following three laboratory courses:**
- **BIO 255 Experimental Genetics (2)**
- **BIO 256 Ecology and Evolution Lab (2)**
- **BIO 257 Experimental Physiology (2)**

Electives
- **8 Biology credits at the 300 level or higher**

Chemistry [15-20 cr]:
- **CHEM 212/216 Organic Chemistry and Lab *or***
- **CHEM 221/225 – 222/226 Organic Chemistry I, II**
- **CHEM 251/255 Quantitative Analysis and Lab**
- **CHEM electives [6-7 credits at 300 level or above]**

Geology [16 cr minimum]: **GEOL 202 plus 4 additional courses at 300 level or above selected under advisement of Geology faculty and major advisor**

III. ELECTIVES

Select additional courses to reach a total of 120 credits for the degree.

If you wish to use transferred courses toward major/minor requirements, you must use the course substitution process. Contact the Academic Advising Center for more information.

It is highly recommended to begin planning your course schedules very early in your college career. Plot out your courses, semester by semester, especially in conjunction with an advisor.

Appendix #2 – Survey Given to Education Majors

TO OUR PRE-SERVICE EDUCATION MAJORS:

The Education and Science Departments of Keene State College are in the process of developing a new second major in General Science for Education majors contemplating certification in elementary (K-8) or middle school (5-9).

You could be enormously helpful to our institution if you:

(a) review, briefly, the advising sheets for these two proposed majors and

(b) answer the questions below.

I. **Present Class**

Freshman _____ **Sophomore** _____

Junior _____ **Senior** _____

II.

Had these General Sciences been in effect when I entered KSC as a freshman, I (choose one):

⬡ **might have considered majoring in General Science with elementary certification**

or

⬡ **might have considered majoring in General Science with middle school certification**

⬡ **would not have been interested in either**

III.

Current Major (other than Education): _____

Appendix #3 – Results of Education Major Survey

SURVEY RESULTS

SPRING 2000

CLASS	ELEMENTARY	MIDDLE SCHOOL	NEITHER
FRESHMAN (194)	36	9	149
SOPHOMORE (31)	5	3	23
JUNIOR (69)	16	5	48
SENIOR (25)	5	2	18

Appendix #4

Preliminary Syllabus: Physics 201- Phenomenal Science

Students in this course will acquire an understanding of basic principles of physics by experiencing activity-based guided inquiry learning suitable for replication with pupils in grades K-8. These activities will use readily available objects contained in kits. The course is being developed by the two physicists.

Motion and Force

Position, speed, acceleration
Projectile motion
Newton's laws
Circular motion

Energy

Work, kinetic and potential energy, power
Law of conservation of energy
(a) Thermal
    Expansion, modes of transfer
    Change of phase
(b) Optical
    Mirrors and lenses
    Applications (camera, telescope, etc.)
    Interference, polarization
    Reflection, refraction, diffraction, dispersion
    Nature of light and its production
(c) Electrical
    Electrostatics
    Circuits
    Magnetism

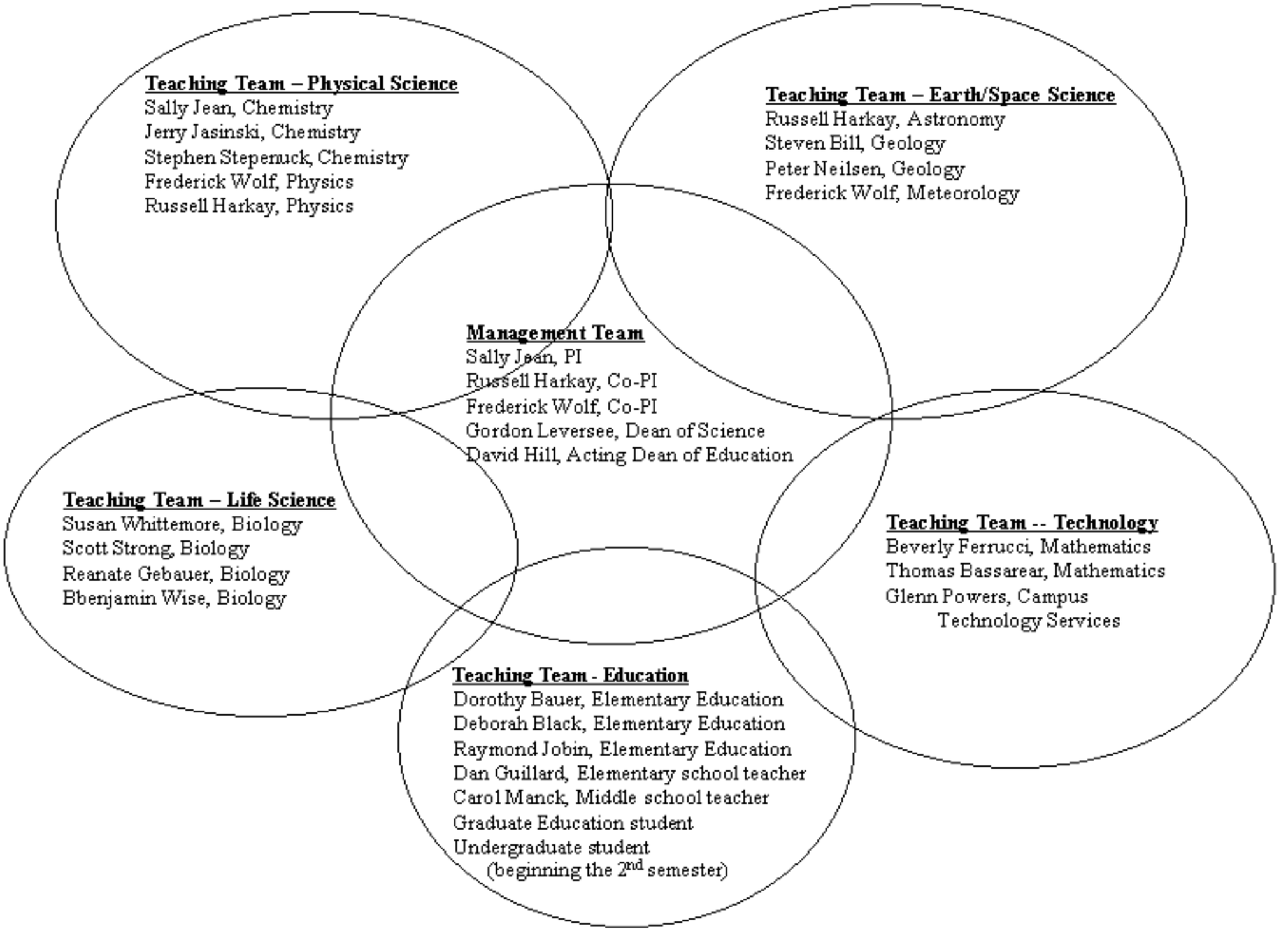
Properties of matter

(a) Gases
    pressure, the atmosphere, sound
(b) Liquids
    density, buoyancy, surface tension
(c) Solids -elasticity, strength

Inquiry based activities

- Reflections in mirror and water prism (geometrical optics and refraction)
- Blowing colorful bubbles (thin films)
- Electrically charging a pie pan (electrophorus, electrostatics)
- Pendulum properties (energy, speed, acceleration)
- Properties of magnets (properties)
- Circuits, series and parallel (electricity)
- Surface tension of water on coin (surface tension)
- Melting ice (phase change)
- Shadows from light bulb (geometrical optics)
- Stick refraction in water (refraction)
- Air drag on falling objects (friction, Newton's 2^{nd} law, acceleration)
- Hot potato! Cooling a boiled potato (specific heat, modes of transfer)
- Helium balloons (flotation, weight, pressure)
- Specific heat of water vs. rocks vs. metals
- Friction (kinetic, static, air)
- Launching projectiles/squirt guns (position, speed, gravity)
- Flying pterodactyl (centripetal motion)
- Fun with sunglasses (polarization)
- Springs (elasticity, energy)
- Sound in bottle, long tube, chimes, strings
- Why things fall down (stability)
- Waves on slinky (energy transport, speed)
- Eggdrop (acceleration, materials)
- Clay boats and ore boat problem (buoyancy and Newton's third law)
- Jello (materials, elasticity)
- Salt solubility and Chinese cooking (surface to volume ratio)
- Egg in salt water (density, buoyancy)
- Capillary action in straws and plants
- Rubber band stretch (elasticity, energy, periodicity)
- Shadow stick (earth-sun relationships, angles, seasons)
- Spool car (friction, energy, circular motion, torque)
- Galileo's heartbeat (acceleration, functional relationships)
- Balancing sticks (inertia, stability)
- Shooting pennies, rock and strings (inertia)
- Tug of war (forces, direction)
- Water barometer (pressure, weather)
- Sunset in a pitcher and blue sky (light, scattering)
- Toilet paper physics (torque, inertia)
- Fun with laser pointers, cross in the screen and CD's (diffraction, refraction)

Appendix #5 – Members of the Teaching Teams and the Management Team of the Web of Science I & II



Appendix #6 – Comparison of New Hampshire Curriculum Framework and NSES

Proficiency Standards	NH State Frameworks (specific)	National Science Education Standards (general)

Science as Inquiry	**1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.**
	By the end of Grade 2:
	• Observe and describe objects in their environment in order to organize information and make comparisons
	• Identify patterns in events
	• Manipulate an object to discover characteristics not apparent by observation alone.
	• Ask "How do we know?" and "Are we sure the same thing will happen the next time?"
	By the end of Grade 4:
	• Describe different types of scientists and the types of questions they ask.
	• Use observations to formulate questions.
	• Observe and identify characteristics that are atypical and use them as a source for questions
	• Communicate results of their observations to other students and teachers.
	• Identify variables when exploring science phenomenon.
		As a result of activities in grades K-4, all students should develop:
		• Abilities necessary to do scientific inquiry
		  • Ask a question about objects, organisms, and events in the environment.
		  • Plan and conduct a simple investigation.
		  • Employ simple equipment and tools to gather data and extend the senses.
		  • Use data to construct a reasonable explanation.
		  • Communicate investigations and explanations.
		• Understanding about scientific inquiry

Proficiency Standards	NH State Frameworks (specific)	National Science Education Standards (general)

Science, Technology, and Society	**2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.**
	By the end of Grade 2:
	• Invent their own unit of measurement.
	• Explain the need for standard universal measurement units.
	• Measure net mass.
	• Use rulers, thermometers, and balances to observe, measure, and construct objects.
	B*y the end of Grade 4:*
	• Invent a tool or device for accomplishing a particular measurement task or goal.
	• Compare the usefulness of various devices and measurement units for accomplishing a particular measurement task.
	• Use tools such as balances, graduated cylinders, tape measures, and stopwatches to make accurate and precise measurements.
	
	2b. Students will demonstrate an increasing ability to use technology to observe nature.
	By the end of Grade 2:
	• Recognize that scientific tools often give more information about things than can be obtained by using our senses directly.
	• Use simple tools in a safe and responsible manner.
	By the end of Grade 4:
	• Discuss the value of using a certain observational tool for investigating a particular phenomenon.
		• As a result of activities in grades K-4, all students should develop:
		• Abilities of technological design.
		  • Identify a simple problem.
		  • Propose a solution.
		  • Implementing proposed solutions.
		  • Evaluate a product or design.
		  • Communicate a problem, design, and solution
		• Understanding about science and technology.
		• Abilities to distinguish between natural objects and objects made by.humans.

- Describe why tools should be used in a safe and responsible manner.

2c. Students will demonstrate an increasing ability to analyze, synthesize, and communicate scientific information using technology.

By the end of Grade 2:

- Use a computer to record observations and to write short descriptions of natural events.
- Share data with children in other classrooms.
- Use age-appropriate instructional software.

By the end of Grade 4:

- Share ideas, data, or summaries of investigations with children at other schools by electronic communication.
- Prepare various types of graphs and tables as means for summarizing and analyzing data which they have collected.
- Use calculators to perform mathematical calculations with data which has been collected and recorded.

2d. Students will demonstrate an increasing ability to understand how technology is used to synthesize new products.

By the end of Grade 2:

- Construct simple structures by following directions.
- Seek out problem in need of solution and invent ways to solve those problems.
- Describe ways the machines are used to manufacture items faster and in greater quantity than one person can do alone.

By the end of Grade 4:

- Talk with local plumbers, electricians, water treatment

personnel, firefighters, etc. to ask questions about how their jobs have changed because of changes in technology.

2e. Students will demonstrate an increasing ability to understand that science and technology affects individuals, and that individuals in turn can affect science and technology.

By *the end of Grade 2:*

- Write and illustrate a story that describes where, for their home, the water comes from and where the sewage goes.
- Describe what would occur if the power at their home was disconnected during a snowstorm, and what behavior changes would be necessary.

By *the end of Grade 4:*

- Explore with parents ways in which their family may participate in recycling, conserving energy, or conserving water.
- Interview parents and grandparents to find out about technologies and products that have disappeared or appeared in their lifetimes.

Proficiency Standards	NH State Frameworks (specific)	National Science Education Standards (general)
Life Sciences	• **3a Students will demonstrate an increasing ability to recognize patterns and products of evolution, including genetic variation, s specialization, adaptation, and natural selection.** *By the end of Grade 2:* • Group students using a particular attribute or characteristic • Distinguish between types of plants by using one or more attributes or characteristics. • Sort a collection of mammal photographs into two or more groups using one or more attributes of characteristics • Collect a variety of seeds and group them using a particular characteristic or attribute. • Visit habitats and describe the organisms generally found in each habitat. • Observe and display understanding of the needs of plants and animals in the classroom by caring for them responsibly. *By the end of Grade 4:* • Examine parts of plants of the same species, recognize variations, and construct graphs and charts showing the variation in one or more attributes or characteristics. • Collect leaves and/or seeds of plants, various insects, or observe birds, and identify the organisms using simple classification keys. • Describe how certain attributes or characteristics of living things are related to their life functions or behavior. • Grow plants from cuttings, bulbs, tubers, etc. and compare them to the parent plant.	As a result of activities in grades K-4, all students should develop understanding of • The characteristics of organisms. • Life cycles of organisms. • Organisms and environments.

- **3b. Students will demonstrate an increasing ability to understand how environmental factors affect all living systems (i.e., individuals, community, biome, the bioshpere) as well as species to species interactions.**

By the end of Grade 2:

- Name plants and animals whose appearance changes in different seasons and describe the differences.
- Discuss features that help plants and animals survive in different environments or in the same environment during different seasons.
- Investigate different habitats to identify some of the ways in which plants and animals which live there depend on each other.

By the end of Grade 4:

- Examine the needs of several organisms and determine how the conditions of a particular habitat can limit the kinds of organisms living there.
- Describe relationships and patterns of interdependence (e.g., food chains or webs, aquaria or terraria) among organisms in particular habitat(s).
- Identify and discuss environmental issues which are important at home and school.

3c. Students will demonstrate an increasing ability to understand that organisms are linked to one another and to their physical setting by the transfer and transformation of matter and energy to maintain a dynamic equilibrium.

By the end of Grade 2:

- Explore the various needs of living things.

- Identify the conditions necessary for the growth of green plants.
- Carry out an experiment to determine the factors needed for seeds to germinate.

By the end of Grade 4:

- Demonstrate an introductory knowledge of photosynthesis, i.e., that green plants make their own food using sunlight, water, and air.
- Place common plants and animals in simple food chains.
- Show evidence hat substances may change form and move from place to place, but that they never appear out of nowhere and never just disappear.

3d. Students will demonstrate an increasing ability to understand fundamental structures, functions, and mechanisms of inheritance found in microorganisms, fungi, protists, plants, and animals.

By the end of Grade 2:

- Identify real or representations (pictures, drawings) of living things found near their home and ask questions concerning their attributes and needs for survival.
- Identify different external features of humans, such as size, shape, color of hair, eye color, ear lobe (attached, unattached) etc.
- Compare pictures of themselves and family members to identify similarities and differences.

By the end of Grade 4:

- Identify structures of some common organisms (e.g., parts of a plant, major organs in the human body).
- Explain how certain structures are related to the successful

survival of that organism (e.g., fish are streamlined, carnivores have sharp teeth).

- Identify major internal systems of both animals and plants and associate them with their function.
- Measure their own pulse rates after different amounts of exercise, collect data, graph results and discuss how pulse rate relates to exercise.

Proficiency Standards	NH State Frameworks (specific)	National Science Education Standards (general)
Earth/Space Science	**4a. Students will demonstrate an increasing ability to understand that the Earth is a unique member of our solar system, located in a galaxy, within the universe.** *By the end of Grade 2:* • Describe how the sky looks at different times. • Describe the changes in the sky's appearance. *By the end of Grade 4:* • Observe patterns of stars in the sky, notice that where they appear in the sky changes over the course of the year. • Describe the motions of stars and planets from direct observations over a period of time. • Use binoculars or a telescope to examine the night sky. • Demonstrate the size and spatial relationships of celestial objects using drawings and/or models. • Describe how astronauts and space vehicles increase our knowledge of the solar system. **4b. Students will demonstrate an increasing ability to understand the Earth is a complex planet with five interacting systems, which consists of the solid Earth (lithosphere), air (atmosphere), water (hydrosphere), ice (cryosphere) and life (biosphere).** *By the end of Grade 2:* • Keep daily records of temperature (hot, warm, cool, cold) and precipitation (some, none, lots) through a period of time and organize the information in a chart or graph.	As a result of their activities in grades K-4, all students should develop an understanding of • Properties of earth materials • Objects in the sky • Changes in earth and sky

- Identify the important attributes of different landscapes (e.g., beaches, mountains, deserts).
- Describe a variety of natural and man-made changes in the earth's surface that they have observed.
- Sort and categorize rocks, minerals and other earth materials using one or more characteristics.

By the end of Grade 4:

- Use maps and globes to explain that most of the earth's surface is covered by water.
- Identify/give examples of geological processes that have shaped New Hampshire's landscape over long periods of time.
- Relate observed weather conditions to different climates and seasons.
- Investigate different stages in the water cycle (melting, freezing, evaporation, condensation).

4c. Students will demonstrate an increasing ability to understand that the Earth contains a variety of renewable and non-renewable resources.

By the end of Grade 2:

- Identify some naturally occurring materials that human begins use for various purposes (water, wood, coal, metals).
- Demonstrate ways in which various materials can be reused or recycled.

By the end of Grade 4:

- Identify two or more renewable and non-renewable resources.
- Describe the process involved in manufacturing a

finished product from raw materials (e.g., gasoline, steel, glass).

- Participate in activities that conserve or recycle natural resources (e.g., turning off unnecessary appliances, class recycling project, class gardening project).

Proficiency Standards	NH State Frameworks (specific	National Science Education Standards (general)
Physical Science	**5a. Students will demonstrate an increasing ability to distinguish among materials by utilizing observable properties.** *By the end of Grade 2:* • Describe objects and events using all of their senses: touch, taste, sound, sight, smell • Construct a variety of different objects from a few types of small parts (e.g., paper clips, toothpicks, coffee stirrers, 3x5 cards, "Legos®", Tinkertoys®") *By the end of Grade 4:* • Investigate what happens to different objects placed outdoors over the course of a school year, such as a steel can, aluminum can, plastic bag, cardboard, limestone, granite, paper. • Inspect, using hand lens or microscopes, substances composed of large numbers of small particles, including homogeneous and heterogeneous materials (e.g., salt, sugar, powdered drink mixes, sawdust, beach sand). • Sort materials according to a given property or attribute (e.g., acids/bases, plant/animal,/ natural/man-made). • Arrange a collection of materials along a continuum (e.g., hardness, density, flexibility, sweetness).	As a result of the activities in grades K-4, all students should develop an understanding of • Properties of objects and materials • Position and motion of objects. • Light, heat, electricity, and magnetism.

5b Students will demonstrate an increasing ability to understand that matter is composed of dynamic interactive units or particles and that all properties and changes in matter can be explained in terms of the forces involved in the interactions of these units.

By the end of Grade 2:

- Describe objects in terms of the materials of which they are made and their physical properties.
- Describe characteristics of matter that are common to solids and liquids, and that distinguish them as different phases of matter.
- Explore how the total mass of an object or device is fixed despite changes in shape.

By the end of Grade 4:

- Describe characteristics of matter that are common to solids, liquids, and gases, and characteristics that distinguish them as different phases of matter.
- Carry out an experiment to show that mass is conserved in a change of state.
- Explore the physical properties of different household substances and substances in nature.

5c. Students will demonstrate an increasing ability to understand the relationship among different types and forms of energy.

By the end of Grade 2:

- Suggest what is required to make things operate (e.g., yo-yos, pinwheels, waterfalls, flashlight, windmills, bicycles).
- Explore (by touch) how the outside temperatures of

containers made of various materials change when filled with hot water.

By the end of Grade 4:

- Measure how the temperature of hot and cold water changes when placed in containers of different materials.
- Measure temperatures before and after a closed bottle of hot water is immersed in a larger container of cooler water and suggest how the changes happened.
- Describe sources of heat, sources of light, sources of their own energy.
- Explain what needs to be done to make things move (e.g., playground equipment, bicycles).

5d. Students will demonstrate an increasing understanding of how electrical and magnetic systems interact with matter and energy.

By the end of Grade 2:

- Classify materials according to their ability to conduct electricity in a light bulb circuit.
- Observe and record the interactions of magnets with various objects.
- Classify materials as interactive or not interactive with magnets.
- Manipulate objects using a magnet.
- Describe safe behavior regarding electricity and lightning.

By the end of Grade 4:

- Explore a variety of electrical circuits with batteries and bulbs.
- Explore the ability of magnets to push or pull objects or

each other.

- Explore the strengths of various magnets. Devise an experiment in which they can accurately rank the magnets from strongest to weakest.

5e. Students will demonstrate an increasing understanding of how an unbalanced force exerted on an object causes a change in the state of rest or motion of that object in the direction of the unbalanced force.

By the end of Grade 2:

- Describe what they feel when riding in a car or school bus when the vehicle starts/stops or goes around corners left/right, and suggest an explanation for what they feel in each case. Devise an experiment with toy cars and objects on them to test their explanations.
- Play the game tug-of-war and discuss the roles of pulling hard and number of pullers on the results. (Safety alert!)
- Observe and describe the various directions in which objects can move.

By the end of Grade 4:

- Explore ways to change the direction of a rolling ball on a hard floor or a hockey puck on ice and what these effects have in common.
- Explore the relationship between mass, force, and motion (e.g., how increasing the mass carried by a snail affects its rate of motion, how difficult it is to stop themselves when running at different speeds).
- Explore various ways to support a heavy book at a certain distance off the floor, such as suspension from a rope, directly holding it, putting a table under it, and

what these approaches have in common.

5f. Students will demonstrate an increasing understanding that energy can be transmitted by waves, using light and sound as examples.

By the end of Grade 2:

- Explore the relationships between shadow size and shape and the position of a light source.
- Investigate light and sound as they come from a source, travel through air, and bounce off objects.
- Observe that sound is created in musical instruments by parts that vibrate (e.g., see and feel vibrating strings, drums, cymbals, loudspeakers).

By the end of Grade 4:

- Observe that waves in a container start at a source, travel along the surface, and bounce off objects, just as do light and sound.
- Explore how sound and light can be concentrated.
- Utilize different types of prisms and lenses to observe what happens when light passes through them.
- Conduct simple experiment to explain how shadows change with changes in the position of the sun or other light sources.

5g. Students will demonstrate an increasing understanding that heat is the product of many natural processes.

By the end of Grade 2:

- Observe how the sun warms the land, air, water, and other objects.
- Observe how their body feels warmer as they increase

their level of activity.

- Identify natural and manufactured objects that produce heat.

By the end of Grade 4:

- Explore how rubbing various things together will produce different amounts of heat.
- Identify sources of heat produced by natural and manufactured objects.
- Observe that most things that produce light also produce heat.
- Explore how heat is related to changes in state from solid to liquid to gas.

Proficiency Standards	**NH State Frameworks (specific)**	**National Science Education Standards (general)**
Unifying Themes and Concepts	• **6a Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.** • *By the end of Grade 2:* • Explore and identify the parts and materials that comprise simple objects and how they are connected (e.g., disassemble common household objects). • Predict the effect of removing or exchanging parts of an object (e.g., a mechanical toy, a jigsaw puzzle). • Discuss how parts, when put together, can do things that they could not do by themselves. • *By the end of Grade 4:* • Assemble a commercial product using manufacture's instruction (e.g., Legos®, plastic models). • Take apart and reassemble simple machines or household appliances. • Design and build a simple device with a desired function from accessible materials. • Describe or demonstrate how something may not work well (or at all) if a part is missing, broken, worn out, mismatched, or misconnected. • Explain, using charts, pictures, and models, an important earth, physical, or life science system (e.g., solar system, home heating system, ecosystem).Suggest several possible uses for a simple object (e.g., a washer on a string, a balance beam)	

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

By the end of Grade 2:

- List several things that change through time or because of a change in the environment.
- Recognize that some changes ae so slow that they are hard to observe (e.g., display monthly photographs of the class and teacher; record and graph monthly the height of each student and the teacher).
- Classify events or objects as changing quickly, slowly, or not at all.
- Observe the movement of people or objects (e.g., record traffic patterns of students moving in the school building).

By the end of Grade 4:

- Conduct an experiment that documents change that is steady, repetitive, or irregular using measurement and graphing (e.g., measure changes in growth of a corn plant stem over periods of days, weeks, and months; positions of the moon in the sky during a period of two month; monitor weather conditions; length of hair).
- Identify and explore conditions that cause things to change more quickly or more slowly.
- Recognize that some changes are so fast that they are hard to see or measure (e.g., use commercial or student-created video images run in slow motion; a toy car rolling down a ramp; one swing of a pendulum).
- Give several examples of steps that one can take to

speed up or slow down change.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

By the end of Grade 2:

- Identify ways in which models are the same or different from the real object (e.g., a plastic flower and a garden flower; a stuffed animal and a real animal; toy car and actual vehicle).
- Describe how a particular occurrence or event is like a different occurrence or event. Anological thinking. (e.g., That person is as busy as a bee; that child is growing like a weed; she is as pretty as a picture).

By the end of Grade 4:

- Create a model for a physical object they can't see (e.g., the contents of a sealed box).
- Represent a familiar object, event, or process using different media and describe how accurate that representation is (e.g., represent a school bus ride using sound, drawing, painting, sculpting, miming).
- Discuss how to change a physical model to make it more realistic.

6d Students will increasingly quantify their interactions with phenomena in the natural world, use these results to understand differences of scale in objects and systems, and determine how changes in scale affect various properties of those objects and systems.

By the end of Grade 2:

- Observe and explore objects in nature and those that are man-made which have very different sizes, masses, ages, and speed.
- Draw simple objects in actual size and compare the drawing to scale picture.
- Explore simple scale models of very large and very small objects that can be made from simple familiar materials (e.g., clay, sand, paper, wood).
- Explore the use of various types of scales that are used in making observations (e.g., thermometers, rulers, color wheels, musical scales).

By the end of Grade 4:

- Compare speeds, sizes, and distances as fractions and multiples of one another.
- Discuss ways to measure size and mass of objects that are either very small or very large, very light of very heavy.
- Map a small area (e.g., classroom, playground, home).

Appendix #7 -- Modules for Web of Science I & II

Kits - Discovery & Inquiry

Web of Science I & II

Grade	Earth/Space	Life	Physical Science	Technology
K	Paper -- FOSS	Myself & Others -- Insights		
	Discovery	**Discovery**		
1st	Habitats -- Insights	Living Things -- Insights	Balls & Ramps -- Insights	Comparing & Measuring -- STC
	Discovery	**Inquiry**	**Discovery**	**Discovery**
2nd	Soils -- STC	Insects -- FOSS	Lifting Heavy Things -- Insights	Balances and Weighing -- STC
	Inquiry	**Discovery**	**Inquiry**	**Discovery**
3rd	Rocks/Mineral --STC	Structures of Life -- FOSS	Chemical Tests -- STC	Ideas & Inventions -- FOSS
	Discovery	**Inquiry**	**Discovery**	**Inquiry**
4th	The Mysterious Powder -- Insights	Human Body -- FOSS	Circuits & Pathways -- Insights	Motion & Design -- STC
	Inquiry	**Inquiry**	**Inquiry**	**Inquiry**
5th	Landforms	Microworlds -- STC	Mixtures & Solutions -- FOSS	Structures -- Insights
	Inquiry	**Discovery**	**Discovery**	**Discovery**
6th	Earth, Moon, and Sun -- FOSS	Food & Nutrition -- FOSS	Levers & Pulleys -- FOSS	Models & Designs -- FOSS
	Inquiry	**Inquiry**	**Inquiry**	**Inquiry**

Appendix #8 – Timeline

December, 2000	Notification of award
May-June, 2001	Creation, in detail, of the three key courses in the General Science program.
June-September, 2001	Acquisition of "hands-on" materials.
School year 2001-02	First offering of pilot courses of PHENOMENAL SCIENCE & THE WEB OF SCIENCE.
May-June, 2002	Review and revision of pilot courses: what worked and what did not.
School year 2002-03	Offering of revised courses.
June-July 2003	Workshops offered to area teachers involving activities, kits and selected portions of courses.

Appendix #9 – New Hampshire General Science Certification Standards

FP 99-171 Fixed 2-14-00

Ed 612.16 General Science For Grades 5-9. The following requirements shall apply:

(a) In compliance with RSA 193-C:3,IV,(f), the teacher preparation program in General Science For Grades 5-9 shall integrate the NH K-12 Science Curriculum Framework, including techniques for enhancing student learning in these areas and the use of assessment results to improve instruction.

(b) The general science program for grades 5-9 shall provide the teaching candidate with the skills, competencies and knowledge gained through a combination of academic and supervised practical experience in the following areas:

(1) In the area of fundamental knowledge, the candidate shall have the ability to:

a. Explain concepts, solve problems, and perform laboratory techniques at an introductory level, equivalent to at least a year of study in each of the following areas:

1. Life science;

2. Physical science; and

3. Earth-space science;

b. Demonstrate a specific content area concentration beyond the general science requirement in one of the following:

1. Biology;

2. Chemistry;

3. Physics;

4. Environmental science; or

5. Earth-space science;

c. Comprehend, apply, evaluate and synthesize knowledge of the following:

1. Fundamental units,

2. Derived units, and

3. Systems of measurement;

d. Apply mathematical and statistical concepts, at least through the level of college algebra;

e. Apply computer technology, hardware and software, to acquire and analyze data and to collect and communicate information;

f. Integrate knowledge from the history and philosophy of science into science instruction; and

g. Use various instniments, including computer-based and manual to observe and record phenomena; and

(2) In the area of instructional performance, the candidate shall have the ability to:

a. Design and teach middle school laboratory activities which incorporate scientific processes and promote scientific habits of mind;

b. Integrate the knowledge of the methods of teaching reading, writing, commw-iication, and study skills essential to the effective mastery of science content at the middle school level;

c. Relate science to technological issues that influence society and the ethical and moral consequences of decisions related to those issues;

d. Model and teach safe laboratory and field practices, including personal safety and equipment storage and upkeep; and waste handling and disposal;

e. Identify the organizations, agencies and 'oumals that contribute to the professional growth of the middle school science teacher;

f Integrate examples of common themes exhibited in all of the sciences into teaching and course design including:

1. Systems;

2. Models;

3. Constancy or stability;

4. Change;

5. Evolution; and

6. Scale;

g. Design learning activities which foster questioning, open-ended investigations, the development of cooperative group skills, and promote practice in decision making and problem solving;

h. Select, adapt, evaluate, and use age-appropriate strategies and materials for the leaming of science, including the recommendations of national curriculum projects and scientific groups, and the framework; and

i. Organize, present, and evaluate science ideas in a manner which emphasizes conceptual understanding and in ways which provide for optimal learning experiences for middle school students of all abili@ levels.

Appendix #10 -- We have identified the following individuals as potential external evaluators:

Dr. MacGregor Kniseley -- Associate Professor of Education, Rhode Island College, Providence, RI. De. Kniseley was the Principal Investigator on the NSF awarded KITES granted that is being adapted and implemented in this proposal.

Dr. Peter Glanz – Full Professor of Physics at Rhode Island College. Dr. Glanz teaches a broad spectrum Physical Science course for Elementary Education majors at RIC.

Dr. Dominique Casavante – Full Profess of Physics at Saint Michael's College in Colchester, VT. He developed "Powerful Ideas in Physics, a project-based Physics course.

Dr. Michelle Lomask – State Department of Education, Hartford, CT. Dr. Lomask is head of the Science teacher evaluation program for certification in the State of Connecticut. She developed the model portfolios that beginning teachers in CT must submit during their second year of teaching. The portfolio must contain proof of inquiry based activities.

Appendix #11 – Letters of Support

Vice President for Academic Affairs
Keene State College
229 Main Street, Keene, New Hampshire 03435-1501
603 358-2106 FAX 603 358-2596
www.keene.edu

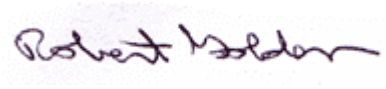
May 26, 2000

To Whom It May Concern:

I am writing in support of the proposal by Keene State College faculty to create three new core courses for Keene State College's new General Science major. These new courses are critical to the new major and will model the kind of innovative pedagogy necessary to revitalize science education in the schools. The courses will help to train a new generation of teachers in these new approaches and will also be offered as an alternative model for the professional development of current teachers.

Keene State College has a deserved reputation as an excellent preparer of future teachers for New Hampshire for New England, and for the rest of the country. We believe that we have the strengths both in the physical and natural sciences and in teacher education to successfully implement this proposal, and to make this proposal one strong step in the national strengthening of science education.

Sincerely,



Robert E. Golden

Vice President for Academic Affairs

REG:pd

Elizabeth M. Twomey
COMMISSIONER
Tel. 603-271-3144

STATE OF NEW HAMPSHIRE
DEPARTMENT OF EDUCATION
101 Pleasant Street
Concord, N.H. 03301
FAX 603-271-1953
Citizens Services Line 1-800-339-9900

May 26,2000

Dr. Frederick Wolf
Science Department
Keene State College
Keene, NH 03435

Dear Dr. Wolf:

The New Hampshire Department of Education has long recognized the importance of quality science instruction for all students. We feel that our public school teachers must be as knowledgeable, as well prepared, as competent, and as inventive as teachers from any other part of the country. The State has taken significant steps to build consensus on the important concept and skills, which should be taught in science. Content and process standards have been identified in state curriculum frameworks. The standards are being used to design a statewide assessment; to develop local school district curricula reflective of the standards; to inform policy changes in collegiate teacher education programs; to set new standards for teacher licensure; and to develop long-range professional development plans at the state and local level.

Your proposal builds upon and complements these statewide initiatives. It takes into account the recommendations of a statewide project conducted by university and college teachers on building a consensus model for pre-service teacher education in mathematics and science (PERP).

It is difficult to teach in ways in which one has not learned and it is a very complex process to design and implement meaningful and effective pre-service experiences for potential teachers of science. The proposal recognizes the need for providing teachers with an opportunity to inquire into methods of teaching the content they are learning as they are learning the content. This will be a very unique and significant change to the way content courses are currently being taught at the collegiate level

Your project will support the college's new commitment for a general science major. What is very important to the State Department of Education is that pre-service teachers will be given an opportunity to learn science content with an emphasize on doing science in a manner that supports the state's science standards. Your willingness to share your experiences with area school districts is highly commendable as well.

The Department appreciates all you have done over the many years in leading statewide reform in science education. Please be advised of my support for your proposal and please keep me informed.

Sincerely,

Edward J Hendry

Dr Edward J. Hendry
Curriculum Supervisor, Science

Dean of Sciences
Keene State College
229 Main Street, Keene, New Hampshire 03435-2001
http://www.keene.edu/

June 1, 2000

Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Director:

I am pleased to write this letter of support for the Project INSPIRE proposal submitted by Drs. Sally Jean and Frederick Wolf in this Division of Undergraduate Education Program. This proposal is a significant step in a many year process to strengthen science teacher education at Keene State College.

Keene State has a distinguished history in the preparation of teachers for New Hampshire and New England. As at most colleges involved in teacher education, however, preparation in the sciences has not kept pace with modern discovery/inquiry pedagogy and content. As Dean, I have facilitated broad efforts to strengthen the sciences at Keene State. These efforts have included hiring many new excellent faculty to replace a cohort or retirees, developing a 5-7 year plan for a major expansion and renovation of science facilities drawing on the resources of Project Kaleidoscope, carrying out short-term renovations of existing facilities, and enhancing laboratory equipment and department budgets.

Dr. Jean is a very experienced new hire in Science Education, while Dr. Wolf is a senior member of our faculty with a long history of involvement in Science Education. Several years of effort have resulted in significant curriculum reorganization and innovation, including the General Science degree program described, which focuses particularly on science preparation of elementary and middle school teachers. The General Science degree program has been well received by outside reviewers and college and university system committees and improvement of Science Education has broad support among Keene State faculty in sciences, mathematics, computer science and education.

I am very familiar with the range of challenges and opportunities involved in implementing this new degree program. I want to make it clear that this effort is of highest priority and has my full support as well as that of our President—a former Professor of Physics—and our Vice President for Academic Affairs.

Sincerely yours,

Gordon J. Leversee
Dean of Sciences

Division of Professional & Graduate Studies

Keene State College

229 Main Street, Keene, New Hampshire 03435-3900
603 358-2220 FAX 603 358-2251
www.keene.edu

May 31, 2000

Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

To Whom It May Concern:

I am pleased to endorse this Keene State College application for funds through the National Science Foundation.

Keene State College has long provided leadership in teacher education for the State of New Hampshire. This project will continue this tradition of leadership by providing pre-service teachers with hands-on experience with discovery and inquiry-based activities for teaching Science at the Elementary and Middle School levels. Support for this project will enable faculty from the Divisions of Sciences and Professional & Graduate Studies to work cooperatively to provide pre-service teachers with the highest standards of teaching effectiveness in the classroom.

I appreciate your thorough consideration of this application.

Sincerely,

David Hill

David S. Hill,
Acting Dean of Professional & Graduate Studies

DH/sew

Appendix #11 - Letters of support

Dear Dr. Sally Jean,

Allow me to introduce myself, my name is Jim Misenti and I am your local sales representative from Prentice Hall Publishers. I spoke with you on June 1, 2000 regarding the possibility of publishing manuals on 'Inquiry Based Learning' for the Elementary and Middle school levels in the area of General Science Education.

Based upon our conversation it sounds like your project would be beneficial to grade school teachers to implement science content based upon the National Science Education Standards.

At your earliest convenience please draw up a table of contents and a brief prospectus so I can submit it to our editor(s) for their review. Depending upon their reaction to this information they may ask you and your colleagues to draft two sample chapters for peer review.

Please let me know if I can provide you with additional information regarding the publishing process at Prentice Hall Publishers.

Sincerely Yours,

Jim Misenti

Jim Misenti

Prentice Hall

SCHOOL ADMINISTRATIVE UNIT NO. 29
JOHN W. DAY EDUCATIONAL CENTER
34 WEST STREET
KEENE, NEW HAMPSHIRE 03431-3392

"A vision of success for every student"

June 2, 2000

Wheelock School
24 Adams Street
Keene, NH 03431

Program Director
Department of Undergraduate Education
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

To the Program Director:

The establishment of three core courses within the framework of the new General Science major at Keene State College by Professors Wolf, Harkay and Jean demonstrates the teacher education leadership at Keene State. Phenomenal Science, and the Web of Science I and II, will provide a discovery and inquiry based science education for KSCs pre-service teacher candidates. We are very fortunate to have in the area the Keene State College faculty and their work with K-8 education majors. That the pre-service teachers will be learning science in exactly the same manner that they will teach it to our elementary students, makes good sense.

As the new General Science Major takes hold, I envision our working collaboratively with Keene State College to reach our common goal of teaching science through inquiry and discovery; through a hands-on approach. The school district curriculum has changed significantly in the past six years, as a result of our participation in the NSRC Science Leadership Institute at the Smithsonian in Washington, DC. It is because of our participation with the institute that we have changed some of the ways we organize and distribute materials and teach science. Our K-12 Science Continuum has been revised to support the national science standards and our elementary teachers are using the best science kits available. Most recently our teachers participated in Science and Technology for Children workshops offered by CESAME at Northeastern University. With our newly gained knowledge we will provide a supportive learning environment for Keene State General Science students. Supervisory Union #29 comprised of six town districts and the Keene School District will most certainly benefit from the new General Science Major at Keene State College. Having the Keene State students teaching in our schools will help increase the scientific literacy of our students and current elementary teachers. Our district, along with those throughout New Hampshire, will continue to benefit in subsequent years as Keene State College graduates fill the elementary classrooms. We support and will urge our district Teachers to attend the 2-day workshop at the conclusion of NSF funding. The workshops should further our district's emphasis on inquiry-based science instruction. Again, I look forward to the establishment of the Keene State College General Science major and feel this is great news for science students at all levels.

Very truly yours,

Dan Gillard

Dan Gillard
K-12 Science Coordinator

DG/np

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