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Student Learning Objectives for a One Semester Junior High Aerospace Course

Jerry Wayne Salstrom

STUDENT LEARNING OBJECTIVES FOR A ONE SEMESTER JUNIOR HIGH AEROSPACE COURSE

A Project Report

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by

Jerry Wayne Salstrom

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CHAPTER ONE

Background of the Study

Introduction

With the successful completion of seven Space Shuttle missions following twenty-five years of successful manned and unmanned space missions, the place of space exploration in man's future had been well established. The economy, politics, public opinion, societal needs, foreign competition, national pride, and similar factors continued to influence particular programs and helped to establish priorities. But the movement of man into the aerospace environment would continue to grow. To capitalize on this resource mankind had to be aware of its possibilities--both beneficial and detrimental to his welfare. The need to educate students about this important part of their environment and their future was becoming increasingly essential.

Yet, some textbooks written before man walked on the moon were still in use; many educators and students had little idea what the term "aerospace" encompassed; and few had much knowledge of the significant and essential ways aerospace activities affected their lives. In an interdisciplinary studies class for seventh and eighth grade gifted students the results of an aerospace pretest showed that only two of twenty-four students were able to name the nine planets. In another class the writer had one seventh grade student who did not know that man had landed on the moon. Many other students did not know whether or not man had landed on either Venus or Mars; some thought the Soviets had made these accomplishments. Other students had difficulty discerning between the events they saw in movies like "Star Wars" and "Star Trek" and actual achievements in aerospace history and technology. While science fiction was an important part of aerospace history and development, there was a need to distinguish reality from fiction, fact from conjecture, and past achievements from future fore-casts. An aerospace curriculum was needed to provide students with the awareness of historical and scientific developments, current technology, career opportunities, influences on society, and possible future direction of aerospace development.

The Problem

In 1977 the Washington State legislature passed the Student Learning Objectives Law (43). That law established a mandate that by 1983 student learning objectives be written for every course offered by Washington public schools. In 1979 the writer received a grant from Educational Service District #113 to develop a one semester junior high aerospace course at Miller Junior High School in

Aberdeen, Washington. In reviewing the literature the writer found little information available regarding specific instructional objectives at the junior high level for aerospace education. While there were some objectives relating to aerospace in science curricula, those were limited to specific scientific principles and/or narrow topics, for example, science in the solar system or meteorology. As de Valois (8:2) said about the State of Washington, "little research had been conducted pertaining to the teaching of aerospace science, especially on the secondary level."

A further problem for those teachers attempting to teach a junior high aerospace course or even aerospace topics within other courses was the lack of teacher time for writing objectives. Sullivan (40:90), Popham (34:16), and Jackson (15:2) all agreed that a need existed to provide teachers with help in specifying objectives. Popham (34:16) suggested, "perhaps we should give him (the teacher) objectives from which to choose, rather than force him to generate his own."

Purpose of the Study

The purpose of this project was to write a list of instructional objectives for a one semester introductory aerospace course at the junior high level. The objectives would be classified by topic for the aerospace class or for interdisciplinary use by teachers in other subject areas. While not all-encompassing, the list would be broad enough to allow some selection by individual teachers in developing their own programs.

Scope of the Study

Because the course would be introductory or survey in nature most of the objectives were written at the lower levels of Bloom's taxonomy. The objectives were designed primarily in the cognitive domain. Few objectives were written in the affective domain. Those objectives requiring construction or manipulation of models or devices were written in the psychomotor domain. While some attempt was made to list interdisciplinary objectives that may be selected for limited use in other subject areas, the prime focus of the objectives was to create a sequence for use in an aerospace course per se.

Most of the objectives were written in the form of instructional objectives as defined below. Some objectives were stated as behavioral objectives (student learning objectives). Instructional objectives were written primarily for use in planning units of instruction, while behavioral objectives stated specific student tasks, and performance objectives stated measurable outcomes for use in evaluation.

General topics addressed in the project were aerospace history, principles of flight and control, aviation uses, astronomy, space exploration, and careers. Specific topics for which objectives were written included the history of flight, lighter-than-air craft, development of the airplane, forces of flight, axes of motion and control, airplane parts and instruments, naviagation, classification and uses of aviation, rockets, manned space flight, space transportation system (space shuttle), earth satellites and planetary spacecraft, the solar system, the universe, and aerospace careers and future possibilities.

Delimitations of the Study

The objectives written for this project were not intended to provide the student with detailed knowledge of scientific principles as might be the case in a science class. Most of the objectives were written to introduce the student to a particular topic and to provide an awareness and establish rudimentary levels of skill and knowledge of that topic. Except for references to earth applications satellites, earth science topics, such as, geology and meteorology, were omitted from the project. While important for comparative studies of planets, earth science topics were not included here because they were introduced in junior high science classes. Other topics relevant to aerospace study, but which required more advanced skills in such areas as mathematics, physics, economics, and politics, were also omitted.

Performance objectives were not included in the project in sufficient detail to meet the definition of a complete performance objective. The establishment of evaluation criteria was left to the teacher. Criteria, such as, number of items, percentage of items correct, time limits and specific performance (product) format, required teacher judgment based on instructional materials, activities, methods, and styles used.

Limitations of the Study

Aerospace education encompassed so many topics and activities that some may have been overlooked. With the rapid expansion of knowledge currently taking place in the aerospace field, much new discovery and technology was not available in a form readily adaptable to instructional use. By the time new data was organized, processed, and published it became outdated or of limited use. Some of the objectives in this project, while current when written, may become of historical interest or outdated as new knowledge replaces or updates them. No scientific survey was conducted to assess the most appropriate and important areas for inclusion in an introductory class. Some teachers may disagree with the importance of those topics or specific objectives selected.

A compromise was made between making the objectives too specific, thereby restricting their portability, and too general, making them little more than broad goals. Performance objectives, especially if written following the ITIP task analysis approach, would have required specific materials, methods, and performance levels. While such an objective was more complete, not all teachers or schools may have had the required materials available. For that reason, the instructional objective format was selected as less restrictive in application. The objectives as written would not provide the teacher with needed criteria for evaluation, however.

Definitions

Aerospace. "As an environment, aerospace included the total expanse extending upward and outward from the surface of the earth (the atmosphere and space). As a field of activity, it included both aeronautics (the study of flight within the atmosphere) and astronautics (the study of flight in space" (12:3).

Aerospace course. Aerospace course included instruction in the topics of aerospace history, kites, balloons, airplanes, rockets, astronomy, principles of flight, navigation, space exploration, space technology and applications, and aerospace careers.

Aerospace education. "Aerospace education was defined as that branch of general knowledge that seeks to communicate knowledge, impart skills, and develop attitudes relative to scientific, engineering, technical, social, economical, and political aspects of aerospace" (12:2).

Behavioral objectives. Behavioral objectives were defined as statements of intended learning outcomes which specified who was to do the learning, what observable behavior the learner would exhibit when demonstrating the learning, and under what conditions the learning would occur.

Goals. Goals were defined as those statements of broad and often long-range intended acquisition of skills and knowledge that were not stated in the more precise and measurable forms of instructional, behavioral, or performance objectives.

Instructional objectives. Instructional objectives were defined as those statements of intended learning outcomes which specify who was to do the learning and what particular behavior was to take place.

Performance. In a performance objective the performance was defined as that product (such as, a written list of terms, a completed model, or an oral book report) that would be produced as a result of some observable behavior (such as, writing, constructing, or speaking).

Performance objective. Performance objectives were defined as statements of intended learning outcomes which specified who was to do the learning, what observable behavior the learner would exhibit when demonstrating the learning, what performance would be produced, under what conditions the learning would occur, and what criteria would be met to demonstrate that learning had occurred to a satisfactory level or degree of accuracy.

Student learning objectives. (See behavioral objectives.)

Organization of the Remainder of the Study

Chapter Two presents a review of the literature in three particular areas--a summary of the research previously conducted regarding secondary aerospace classes and resources in Washington State, a survey of instructional objectives available in secondary/junior high curriculum guides, and a brief summary of commercial materials related to junior high aerospace education.

Chapter Three describes the procedures used in developing and classifying the instructional objectives.

Chapter Four is the primary product of the project--a list of instructional objectives to be used in a one semester junior high aerospace class.

Chapter Five presents a summary of the project with conclusions and recommendations for further research and development of secondary aerospace studies.

CHAPTER TWO

Review of Selected Literature

Few studies addressing aerospace education, especially at the junior high level, were found in the literature. What research had been done generally studied the number of aerospace courses or units within courses being taught in Washington State. Isaac (14) and de Valois (8) also studied the qualifications of teachers teaching those courses. While Jackson (15) did a study of aerospace topics as taught in the sixth grade and Frizzell (9) offered a program for instruction in model rocketry, no work was found regarding a comprehensive aerospace program. Hamilton (12) addressed the need to coordinate resources for teachers by compiling a directory of statewide aerospace education services in the State of Washington.

Research established that aerospace topics and courses were being taught and efforts to provide assistance to teachers in obtaining instructional materials were being made. The National Aeronautics and Space Administration and the Federal Aviation Administration both provided materials, especially films, posters, books, and other print and audio-visual materials for classroom use. Many private aerospace companies provided some materials related to specific topics. Central Washington University and the Washington Aerospace Association offered teacher workshops in aerospace education.

Both Beech (1) and Cessna (27) aircraft companies published instructional kits including objectives. Both kits, however, were limited to the general topics of principles of flight, aircraft controls, general aviation, and careers. The objectives in those kits were not written in a form that met the criteria of this project. While both kits met some needs they were not sufficient for teaching a more comprehensive aerospace course. A more ambitious work published by Jeppesen Sanderson (16, 17, 18, 19) was very thorough in its coverage of many aviation topics in aerospace education. The objectives, however, again failed to meet the criteria of this work. Most were stated as educational goals rather than as specific instructional objectives. The major goal of the Sanderson program was pilot training. The text and workbook emphasized many of the technical aspects of flight in greater detail than was necessary for an introductory junior high program. The general level of the Sanderson work was beyond a junior high program.

The Civil Air Patrol (4, 5, 6) published Aerospace: The Challenge, an excellent text for secondary level aerospace instruction. The Civil Air Patrol (2, 3, 7) had also published two paperback texts for cadet training, Your Aerospace World and Aerospace '81. Both were somewhat condensed versions of Aerospace: The Challenge. An appendix containing specific behavioral objectives was added to Aerospace '81. That set of objectives was the most complete and well organized found in the literature. The objectives addressed a major part of the topics of interest to this project. The emphasis was primarily on aviation, especially aircraft types, pilot training, and military activity. The objectives regarding space dealt primarily with spacecraft. There were no objectives directly related to astronomy, the solar system or universe. Because the objectives were intended for training of Civil Air Patrol cadets, many objectives were more detailed or specific than required for a one semester introductory course.

Several school districts across the country had also included aerospace topics in their science curriculum guides. Two major weaknesses prevailed. First, most of the objectives were stated in the form of general goals, not as specific instructional objectives. Second, the aerospace topics and activities selected were very narrow in scope. The most common units included were meteorology, the solar system, and the study of the physical properties of motion, gravity, and light. The Tri-County Goal Development Project (25), Multnomah County, Oregon, included an extremely comprehensive set of instructional goals for the study of the solar system and universe. Only one curriculum guide (31) was found that included a comparatively comprehensive study, even on an introductory level, of aerospace education per se.

Galbreath (29:117) presented a series of aerospace study units specifically for junior high school. Organized in the form of a curriculum guide, the units included were "Impact of the Aerospace Age," "History of Flight," "Principles of Flight," "Realms of Flight," "Navigation and Communication," and "Satellites and Space Travel." Each unit was prefaced by a set of instructional goals, provided an outline of topics to be studied, and was followed by suggestions for pupil experiences and activities. No behavioral objectives were included.

Such resources notwithstanding, few attempts were made to clearly define the specific instructional objectives of a comprehensive aerospace program. After surveying aerospace courses in grades nine through twelve, de Valois (8) concluded that there was little consistency in the topics and subjects being taught.

CHAPTER THREE

Procedure

A search of the literature was conducted to determine (1) what areas of aerospace education had been reviewed, (2) what materials were available and appropriate to the junior high level, and (3) what specific instructional objectives had already been written and made available to teachers.

The topics for inclusion in the one semester course were selected.

Appropriate texts and other instructional materials were selected and reviewed. The primary sources were included in a list of references.

Instructional objectives were written for each of the selected topic areas and units of study.

The objectives were sequenced under the major headings: Aerospace History, Lighter-than-air and Unpowered Aircraft, Principles of Flight and Control, Airplane Parts, Instruments and Navigation, Aviation Classifications and Uses, The Solar System and Universe, Space Exploration, and Aerospace Careers and Awareness.

After sequencing, the objectives were numbered consecutively.

An example of how to adapt an objective to the six levels of Bloom's Taxonomy of Educational Objectives (42:9) was developed.

The objectives were then cross-referenced as appropriate among topic areas; selected objectives were also categorized by academic subject area for interdisciplinary use.

A list of references from which objectives were developed was compiled.

CHAPTER FOUR

The Project: Student Learning Objectives for a One Semester Junior High Aerospace Course

The material presented in this chapter was organized in the format to be made available for use by classroom teachers. The final product was a list of instructional objectives for a one semester junior high aerospace course. The organization of the final product included an introduction and explanation of the objective sequence, the objectives themselves, an example of possible adaptation to Bloom's Taxonomy of Educational Objectives, cross-referencing, a suggested semester plan, and selected references the teacher may find useful in planning an aerospace course.

STUDENT LEARNING OBJECTIVES FOR A ONE SEMESTER JUNIOR HIGH AEROSPACE COURSE

Introduction

One of the major concerns about the quality of education has been the lack of emphasis on mathematics and science. The current era has been called the "Age of Technology," "Computer Age," "Information Age," "Space Age," or "Aerospace Age," all of which are interrelated. Technological development of the aerospace environment has been growing rapidly, as has the need to become aware of the possibilities of this technology--both beneficial and detrimental to mankind. The need to educate students about this important part of their environment and future has become essential. Many educators and students have little idea about what the term "aerospace" encompasses; nor do they have much knowledge of the significant and essential ways aerospace activities affect their lives.

Aerospace activities are highly visible as subjects of such media as movies, television shows, news reports, magazine articles, children's toys, models, posters, books, and other printed materials. What is learned from those activities is difficult to measure without some organized evaluation process. Some program of study must be undertaken to distinguish between reality and fiction, fact and conjecture, past achievement and future forecast. An aerospace curriculum is needed to provide that knowledge, either through interdisciplinary lessons, such as in history and science classes, or as a separate course offering.

In 1979 an aerospace course was developed at Miller Junior High School, Aberdeen, Washington, with the aid of a grant from Educational Service District #113. In 1977 the Washington State Legislature passed the Student Learning Objectives Law (RCW 28A.58.092) mandating that student learning objectives be written for every course offered by Washington public schools. The following sequence of instructional objectives has been written both to meet the requirements of the law and to assist teachers in developing aerospace education programs. Hopefully, these will be helpful to teachers who wish to include aerospace topics in their present classes or who wish to develop an aerospace class per se, but who do not have the time to write their own objectives.

The objectives themselves have been numbered consecutively from 1 to 419 and categorized under the headings: Aerospace History, Lighter-than-air and Unpowered Aircraft, Principles of Flight and Control, Airplane Parts, Instruments and Navigation, Aviation Classifications and Uses, The Solar System and Universe, Space Exploration and Aerospace Careers and Awareness. It is not intended that every objective be met by every student, nor that every objective be included in any one course. The teacher is encouraged to select objectives as appropriate. While an attempt was made to sequence the objectives either chronologically (such as history objectives) or by level of development (such as flight control objectives), there is no one "best" order. The teacher may wish to write additional objectives not addressed here. The teacher may also wish to rewrite or adapt an objective to another level of learning vis-a-vis Bloom's Taxonomy of Educational Objectives. An example of such a hierarchy follows the list of objectives. Following the example is a cross-referenced listing of related objectives from other categories, a list of selected objectives categorized by academic subject area, and a suggested one semester plan. Finally, a list of selected resources is presented.

Aerospace History

1. The student will recite three legends of flight from early China.

2. The student will recite the myth of Daedalus and Icarus.

3. The student will illustrate man's early interest in flight by describing evidence relating to flight from early Babylonia, Egypt, South America, Greece, and Rome.

4. The student will write a report briefly describing the early history of the kite.

5. The student will write a description of the early uses of rockets by the Chinese.

6. The student will describe man's early attempts to fly by describing ornithopters and tower jumpers.

7. The student will describe in writing Leonardo da Vinci's experiments in aviation.

8. The students will explain why da Vinci's experiments did not contribute significantly to the development of flying machines.

9. The student will explain how better communication and information storage in da Vinci's time may have changed the history of aviation.

10. The student will recite the story of the possible invention of the hot air balloon by Father Gusmao including date, country, and details of his demonstration.

11. The student will describe the use of kites by the Japanese architect Kawamura Zuiken in 1689 and the thief Kakinoki in 1712.

12. The student will list the aeronautic achievements of Alexander Wilson.

13. The student will compare the kite experiments of Alexander Wilson with those of Benjamin Franklin.

14. The student will describe the sequence of events that led the Montogolfiers to invent the first hot air balloon.

15. The student will describe the development of ballooning from 1783 to 1800 including at least five recorded "firsts."

16. Given a list of individuals and a separate list of aviation events occurring from 1500 to 1800 the student will match each individual with the appropriate corresponding event. The individuals will include: Dr. Joseph Black, Jean Pierre Blanchard, Tiberius Cavallo, Henry Cavendish, J. A. C. Charles, William Congreve, Marquis d'Arlandes, Leonardo da Vinci, Francesco de Lana, Pilatre de Rozier, Benjamin Franklin, Jacques Garnerin, Madame Jeanne Garnerin, Father Gusmao, Dr. John Jeffries, J. B. M. Meusnier, Entienne Montgolfier, Joseph Montgolfier, Joseph Priestley, Madame Thible, George Washington, and Alexander Wilson.
    The events will include:
    - first scientific experiments in aviation
    - first demonstration of hot air balloon flight
    - discovered hydrogen
    - wrote of "ariel ships"
    - first to realize hydrogen filled balloon would rise
    - experimented with hydrogen filled soap bubbles
    - discovered oxygen and studied properties of air
    - used heat from fire to make a small silk bag rise
    - brothers who invented hot air balloon
    - first aeronauts
    - first to fly in a hydrogen balloon
    - first woman to fly as a passenger
    - wrote of military importance of balloons to the U.S.
    - first to cross English Channel by air
    - first balloon flight in America
    - witnessed first balloon flight in America
    - invented rockets referred to in the Star-Spangled Banner
    - suggested changing balloons to the shape of a football
    - first woman to fly alone in a balloon
    - first parachute jump from a balloon
    - first to be killed in an aircraft
    - studied kites and electricity in Scotland

17. The student will identify the terms "flammable air" and "Montgolfier Gas."

18. The student will list the first animals to fly and to orbit the earth in a spacecraft (both Russian and American).

19. The student will participate in a class discussion about why animals were used in aerospace "firsts" and how animals are used in scientific research today.

20. The student will describe three ballooning events witnessed by Ben Franklin, George Washington, and Abraham Lincoln including dates, places, significant persons involved and Franklin's and Lincoln's attitudes toward balloon uses.

21. The student will write a biographical sketch of Sir George Cayley, including a summary of his contributions to aviation.

22. Given the following ten events, the student will arrange them in chronological order: the first lift of an airplane under its own power, the invention of the kite, the first flight of a manned hot air balloon, the first flight of a lighter-than-air craft in America, the first parachute jump from an aircraft, Otto Lilienthal's death, the first flight of manned hydrogen balloon, the modern design of the airplane, Leonardo da Vinci's design for a helicopter, and the invention of the dirigible.

23. The student will describe the uses of kites in the U.S. from 1880 to 1910.

24. The student will describe the role of the kite in the first trans-Atlantic radio signal transmission.

25. The student will list the three mechanical methods of flight control used by Otto Lilienthal.

26. The student will describe the development of the dirigible including contributions by J. B. M. Meusnier, Henri Giffard, Charles Renard, A. C. Krebs, Paul Hanlein, Alberto Santos-Dumont, and Ferdinand von Zeppelin.

27. The student will list the types of propulsion used to power dirigibles from 1853 to 1914.

28. The student will compare the types of propulsion used for dirigibles and balloons in the 19th century with the types of propulsion used for sea and land travel during that time.

29. Given a list of individuals and a separate list of aviation events occurring from 1800 to 1900 the student will match each individual with the related event. The individuals will include: Sir George Cayley, Octave Chanute, Henri Giffard, William Hale, Paul Hanlein, Joseph Henry, W. S. Henson, A. C. Krebs, Samuel P. Langley, Otto Lilienthal, Abraham Lincoln, S. C. Lowe, John J. Montgomery, Charles Renard, Alberto Santos-Dumont, Gen. Winfield Scott, John Stringfellow, and Count Ferdinand von Zeppelin.

The events will include:

U.S. President who supported use of balloons
organized Balloon Signal Service of the Union Army
opposed use of balloons in the Civil War
first Secretary of the Smithsonian Institution
invented rocket used in the Civil War
invented the powered gas bag or blimp
invented first successful dirigible
first dirigible steered back to its takeoff point
invented the "LaFrance"
first known internal combustion powered dirigible
built and flew first successful rigid dirigible
built and flew man carrying gliders in California
has been called the "father of modern aviation"
paper laid foundation for modern aeronautics
designed the Ariel
first successful powered flight of heavier-than-air craft
flew steam powered model and received $50,000 from Congress
noted for careful study and collecting aviation information

30. The student will write a brief summary of the process the Wright Brothers used to learn about and build their first aeroplane.

31. The student will name the two things the Wright Brothers had to design, build and add to their glider to achieve powered flight.

32. The student will describe each of the Wright Brothers' four gliders and their test flights from 1900 to 1903.

33. The student will describe the Wright Brothers' two major contributions to controlled flight--wing-warping and the rudder.

34. The student will contrast the Wright Brothers' approach to powered flight with the approach of those who preceded them.

35. The student will compare the press coverage given to Langley's Aerodrome to that given to the Wright Flyer.

36. The student will explain why the Wright Brothers did not fly in 1906 or 1907.

37. The student will identify the two major aviation events of 1909 and explain why they were important.

38. The student will list three aviation firsts recorded by Harriet Quimby.

39. The student will describe the major problem in the development of helicopters and list two possible solutions.

40. The student will describe the world's first commercial airship and airline including dates, miles travelled, number of passengers carried, and safety record.

41. The student will identify each of the following: the Wright Flyer, June Bug, Vin Fiz Flyer, the Aerodrome, the Triple Twin, the Le Grande, and the Gnome.

42. The student will describe the basic difference between a rotary and a radial aircraft engine.

43. The student will explain why the years from 1904 to 1914 were called the "Formative" or "Growth Years" in aviation.

44. Given a list of individuals and a separate list of aviation events occurring from 1900 to 1914 the student will match each individual with the related event. The individuals will include: Thomas Baldwin, Alexander Graham Bell, Emile and Henry Berliner, Louis Bleriot, Louis Breguet, Paul Cornu, Glenn Curtiss, Eugene Ely, Lt. Frederic E. Humphreys, Tony Jannus, Lt. Frank P. Lahm, Harriet Quimby, Baroness de la Roche, Calbraith P. Rodgers, Theodore Roosevelt, Alberto Santos-Dumont, Blanche Scott, Lt. Thomas Selfridge, Igor Sikorsky, Charles Taylor, Orville Wright, and Wilbur Wright.
The events will include:
    built the first seaplane in America
    built the first monoplane
    flew the Vin Fiz Flyer
    first woman to solo
    first American woman to fly
    first licensed woman pilot
    first person killed in an airplane
    first two army pilots
    built and flew the first helicopter
    built and flew the first American helicopter
    first airline using aeroplanes
    founded the Aerial Experiment Association
    motorcycle racer who flew the June Bug
    the Wright Brothers' mechanic
    built first four-engine aircraft
    built first powered dirigible in U.S.
    first airplane flight in Europe
    first takeoff and landing from a ship
    flew second helicopter in Europe
    built aircraft factory in France
    first airplane flight across the English Channel
    tested and sold first airplane to U.S. Army

45. The student will state the purpose for which the NACA was founded in 1915.

46. The student will describe the military use of the airplane during the first year of World War I.

47. The student will describe the development of "fighter" aircraft in WWI with reference to the invention of Roland Garros and Anthony Fokker.

48. The student will describe the Lafayette Escadrille.

49. The student will define the terms "Ace" and "Ace of Aces."

50. The student will list the "Ace of Aces" of Germany, France, England, and the United States in WWI.

51. The student will describe the accomplishments of Billy Mitchell, Frank Luke, and Eddie Rickenbacker during WWI.

52. The student will list three reasons why no U.S. airplane was built to see action in WWI.

53. The student will write a brief description of the development of the military uses of aircraft during WWI and cite an example depicting each use.

54. The student will make a table comparing the speed, altitude ceiling, and engine horsepower of airplanes at the beginning and end of WWI.

55. The student will cite at least five changes that occurred in airplanes as a result of warfare in WWI.

56. The student will describe the growth of the U.S Army "Air Force" from 1908 to 1917.

57. The student will compare the development of aviation in Europe immediately following WWI with that in the United States.

58. The student will define the terms barnstormer, wing-walking, and stunt-flying.

59. The student will describe the trans-Atlantic flights of Read and Alcock and Brown.

60. The student will list natural "barriers" that provided challenges and incentives for the improvement of aircraft throughout aerospace history.

61. The student will describe the planes, route, time, and distance flown on the first round-the-world flight.

62. The student will list at least five aviation firsts recorded by Army pilots during the 1920's.

63. The student will describe the events that led to the court-martial of Billy Mitchell.

64. The student will play a role in a class reenactment of the court-martial of Billy Mitchell.

65. The student will write an analysis of how history might have been changed if government and especially military leaders of the 1920's had believed Billy Mitchell's claims about the use of airplanes in warfare.

66. The student will present one side of a debate on whether Billy Mitchell could have suffered the same fate today.

67. The student will write a brief biographical sketch of Billy Mitchell describing his accomplishments from age 15 to retirement.

68. The student will describe the development of U.S. airmail from 1918 to 1930.

69. The student will list the provisions of the Air Commerce Act of 1926.

70. The student will outline the history of the rocket to 1926.

71. The student will describe the first "blind" takeoff and landing by Jimmy Doolittle in 1929.

72. The student will list at least 10 improvements made in aeronautics during the 1920's.

73. The student will describe three prizes offered to aviators by newspaper publishers from 1900 to 1935.

74. The student will name the major air races during the 1920's and 1930's.

75. The student will describe the Pulitzer, Thompson, Bendix, and Schneider Trophy races.

76. The student will summarize the provisions and ultimate effect of the McNary-Watres Act of 1930.

77. The student will name the founders of the Travel Air Manufacturing Company.

78. The student will describe the founding of aircraft companies by Stearman, Cessna, Beech, Taylor, and Piper from 1925 to 1935.

79. The student will describe the Boeing 247 built for United Airlines in 1932.

80. The student will describe the development of the B-17 bomber in the 1930's.

81. The student will describe the development of the DC-1, DC-2, and DC-3.

82. The student will state the meaning of the initials "DC" in planes such as the DC-3 or DC-10.

83. The student will identify the passenger aircraft developed for United Airlines, TWA, American Airways from 1932 to 1935.

84. The student will describe the service offered by Pan American Airways from 1927 to 1945.

85. The student will list and describe the types of airplanes flown by Pan American Airways before World War II.

86. The student will describe the fates of the Shennandoah, Akron, and Macon.

87. The student will describe the fate of the Hindenburg.

88. The student will list the names of the dirigibles used by both Germany and the United States between WWI and WWII.

89. The student will name the inventor of the first practical helicopter.

90. The student will describe the contributions to rocket research made by Robert Goddard, Konstantin Tsiolkovsky, and Herman Oberth.

91. The student will explain why the period from 1919 to 1939 was called the "Golden Age of Aviation."

92. The student will describe the German tactic called "Blitzkrieg."

93. The student will describe the "Battle of Britain."

94. The student will explain how a navigation error on August 24, 1940, changed the course of WWII.

95. The student will describe the German V-2 missile.

96. The student will name and describe the first jet aircraft.

97. The student will describe the event that brought the United States into World War II.

98. The student will describe the Ally air strategy used to defeat Germany in WWII.

99. The student will define "island hopping" and the role of aircraft in fighting WWII in the Pacific.

100. The student will describe the bombing of Hiroshima and Nagasaki.

101. The student will summarize the development of jet aircraft during World War II.

102. The student will list the jet aircraft developed during World War II and designate which saw action in the war.

103. The student will describe the uses of kites during WWII.

104. The student will write a summary of how warfare changed the airplane referring specifically to World Wars I and II.

105. The student will write a summary of how airplanes changed warfare referring specifically to World Wars I and II.

106. The student will compare the attitude toward military air power at the beginning of World War I to that at the end of World War II.

107. The student will describe the reorganization of the American air force in 1947.

108. The student will state the primary purpose of the U.S. Air Force as formed in 1947.

109. The student will name the aircraft and pilot who first flew faster than the speed of sound.

110. The student will describe the Berlin Airlift of 1948.

111. The student will describe the strategic advantage held by Communist Chinese aircraft in the Korean War.

112. The student will describe the effect of close air support for ground troops during the Korean War.

113. The student will describe the uses of the helicopter during the Korean War.

114. The student will identify the first commercial jet aircraft.

115. The student will summarize the development of rockets and missiles by the United States and Russia before 1958.

116. The student will place the work of the following in chronological order: Robert Goddard, Isaac Newton, Werner von Braun, Leonardo da Vinci, Sir George Cayley, Otto Lilienthal, the Wright Brothers, and the Montgolfier Brothers.

117. Given a list of individuals and a separate list of aviation events occurring from 1914 to 1957, the student will match each individual with the related event.
The individuals will include: John Alcock, Arthur Brown, Jimmy Doolittle, Amelia Earhart, Anthony Fokker, Roland Garros, Robert Goddard, Daniel Guggenheim, Hugo Junkers, Charles Lindbergh, Billy Mitchell, Herman Oberth, Albert Read, Manfred von Richtofen, Eddie Rickenbacker, Igor Sikorsky, Konstantin Tsiolkovsky, Werner von Braun, Frank Whittle, Woodrow Wilson, and Chuck Yeager.
The events will incude:
American "Ace of Aces"
known as the Red Baron
authorized the NACA
first trans-Atlantic solo by a woman
first non-stop trans-Atlantic flight
first trans-Atlantic flight
first non-stop trans-Atlantic solo
first "blind" flight
designed first turbojet engine
first to break the sound barrier
first all-metal aircraft
first launch of a liquid fuel rocket
sank the Ostfriesland
contributed to aeronautic research
research on liquid rocket fuel
research led to the German V-2 rocket
developed the V-2 rocket

mounted a rifle on an airplane
designed interrupting gear for aircraft rifle
designed first practical helicopter

118. The student will identify the name and date of the first Russian and American satellites.

119. The student will summarize the reaction of the United States to the launching of Sputnik I.

120. The student will describe the affect of the launching of Sputnik I on American schools.

121. The student will compare the attitude toward American schools following Sputnik with the general attitude toward American schools today.

122. The student will state the purpose for which NASA was formed in 1958.

123. The student will state the aerospace responsibilities given to the Department of Defense in 1958.

124. The student will identify the first American commercial jet aircraft.

125. The student will list the achievements of the X-15 series of experimental aircraft.

126. The student will describe America's three manned space programs from 1960 to 1972.

127. The student will compare and contrast the first voyage of Columbus to America with the first landing of man on the moon including references to transportation vehicles, provisions, navigation, financial support, and preparation (including major known and unknown facts about their intended destinations).

128. The student will compare and contrast man's exploration of the new world in the late 15th and early 16th centuries with man's exploration of the moon.

129. The student will describe the accomplishments of the Apollo-Soyuz mission of 1975.

130. The student will describe the four modules of the Skylab space station.

131. The student will list at least five areas of research conducted aboard Skylab.

132. The student will describe the misfortunes of Skylab that occurred during launch and after the last manned mission.

133. The student will identify the aviation first that Bryan Allen, Louis Bleriot, and Jean Pierre Blanchard and John Jeffries had in common.

134. The student will explain the significance of the English Channel to aviation by citing specific events.

135. The student will describe an aviation event first achieved by each of the following: Maxie Anderson, Ben Abruzzo, and Larry Newman; Robert Crippen and John Young; Blanche Scott; Madame Thible; Amelia Earhart; Sally Ride; Orville and Wilbur Wright; Joseph and Entienne Montgolfier, Bryan Allen; Ferdinand von Zeppelin; Chuck Yeager; Sir George Cayley; Tony Jannus; Jean Pierre Blanchard; Yuri Gagarin; Neil Armstrong; Charles Lindbergh; and John Glenn.

136. The student will identify the aerospace first that occurred on each of the following dates: November 21, 1783; December 17, 1903; March 16, 1926; May 21, 1927; August 6, 1945; October 14, 1947; October 4, 1957; January 31, 1958; April 12, 1961; May 5, 1961; February 20, 1962; July 20, 1969; July 26, 1976; August 23, 1977; August 17, 1978; April 14, 1981; and June 13, 1983.

137. The student will construct a time line showing at least 30 significant events in the history of aviation from 3000 B.C. to 1980 A.D. including at least two references each to kites, rockets, balloons, dirigibles, gliders, airplanes, and scientific discoveries related to flight.

138. The student will identify an aerospace first recorded by each of the following: Madame Thible, Madame Jeanne Garnerin, Blanche Scott, Harriet Quimby, Amelia Earhart, Valentina Tereshkova, and Sally Ride.

139. Shown pictures or diagrams of the following, the student will identify each by name: an ornithopter, Montgolfier balloon, Lilienthal glider, Zeppelin dirigible, Cayley's first airplane, the Wright Flyer, The Spirit of St. Louis, a Bleriot monoplane, a box kite, Oriental fighting kite, diamond kite, seaplane, helicopter, 747, modern sport balloon, modern hang-glider, an ultra light, sailplane, da Vinci's helicopter, a small general aviation airplane, Apollo spacecraft, and the Space Shuttle.

140. The student will name the fighters and bombers that have been added to Air Force and Navy inventory since 1958.

141. The student will list the commercial jet aircraft produced by Boeing, Douglas, and Lockheed since 1958.

142. Given a list of individuals and a separate list of aerospace events occurring from 1957 to 1983, the student will match each individual with the related event and vehicle.
The individuals will include: Ben Abruzzo, Bryan Allen, Maxie Anderson, Neil Armstrong, Robert Crippen, Scott Crossfield, Yuri Gagarin, John Glenn, Laika, Larry Newman, Francis Gary Powers, Sally Ride, Alan Shepard, Valentina Tereshkova, Joe Walker, Bob White, and John Young.
The events will include:
first woman in space
first American woman in space
first man in space
first American to orbit the earth
first American in space
first animal in space
first space shuttle crew
first human-powered flight
first trans-Atlantic crossing by balloon
American spy
flew X-15 to speed record
flew X-15 to altitude record
first X-15 pilot
The vehicles will include: the space shuttle, X-15, Freedom 7, Vostok I, Sputnik II, U-2, Apollo 11, Double Eagle II, Gossamar Albatross, and Gossamar Condor.

143. The student will describe at least two major events or contributions to aviation by each of the following countries: China, Russia, England, Germany, France, Canada, Italy, and the United States. The description must include the date of the event and, where known, the name of the individual(s) responsible for the accomplishment.

144. The student will write a biographical sketch of the following: Leondardo da Vinci, the Montgolfiers, Sir George Cayley, Count Ferdinand von Zeppelin, Otto Lilienthal, the Wright Brothers, Glen Curtiss, Jimmy Doolittle, Charles Lindbergh, Robert Goddard, Amelia Earhart, Harriet Quimby, and Werner von Braun. The sketch should emphasize contributions to aviation including dates, locations, and descriptions of inventions, discoveries, or achievements.

145. The student will describe the first achieved by Yuri Gagarin, Alan Shepard, John Glenn, Neil Armstrong, John Young, and Robert Crippen.

146. The student will write a description of each of the following U.S. manned space programs including space firsts: Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, Space Shuttle, and X-15.

147. The student will write an outline or timeline of the history of space exploration.

Lighter-than-air and Unpowered Aircraft

148. Given a paper bag, scissors, tape, and string the student will construct and fly a sled kite.

149. Given necessary materials, the student will construct a diamond kite.

150. Given necessary materials, the student will construct an Oriental snake kite.

151. Given necessary materials and a pattern, the student will construct a delta-kite.

152. Given necessary materials, the student will construct and fly a kite of his/her own design.

153. The student will explain the effect of the length of the tail on a kite.

154. Shown examples of various types of kites the student will classify them as high-, moderate-, or low-wind kites.

155. The student will compile a list of historical uses of kites and describe in detail at least three events involving the uses of kites.

156. The student will list at least ten current uses of kites around the world.

157. Given balsa sticks, tissue paper, glue, string, and scissors, the student will construct and fly a model hang-glider.

158. Given a pattern, tissue paper, glue, string, tag board, and instructions, the student will construct and launch (with supervision) a paper hot air balloon.

159. The student will explain how lift is created in lighter-than-air craft by the use of hot air, hydrogen, and helium.

160. The student will list the major sources of lift in lighter-than-air craft and at least one advantage and one disadvantage of each.

161. The student will read a part in the classroom presentation of the drama "Night Crossing."

162. The student will act a role in a presentation of the drama "Night Crossing."

163. The student will describe the distinguishing characteristics of balloons, blimps, and dirigibles.

164. The student will define rigid, semi-rigid, and non-rigid as they relate to lighter-than-air craft.

165. The student will write a detailed description of a historical military event involving each of the following: a kite, a balloon, and a dirigible.

166. The student will briefly describe at least three types and uses of lighter-than-air craft including the class of craft and source of lift.

167. The student will identify the only dirigibles or blimps used in the U.S. today.

168. The student will describe hang-gliders, sailplanes, and ultralights.

169. Given a pattern, scissors, razor blade, straight pin, penny, and a styrafoam egg-carton or meat tray, the student will construct and fly a styrafoam glider.

170. The student will describe the possible uses of lighter-than-air craft in the future.

171. The student will describe a possible use of lighter-than-air craft in future space exploration.

172. The student will write a description of each of the following terms: ornithopter, tower jumper, lighter-than-air craft, heavier-than-air craft, kite, blimp, dirigible, glider, soaring, sailplane, aeronaut, aviator, and astronaut.

Principles of Flight and Control

173. The student will list the three basic problems of flight.

174. The student will list the four forces of flight.

175. The student will identify a phenomena that produces each of the four forces in the flight of kites, gliders, balloons, and airplanes.

176. The student will describe and give an example of each of Newton's three laws of motion.

177. Given diagrams of physical phenomena involving motion, the student will classify each as an example of one of Newton's three laws of motion.

178. The student will state Bernoulli's Law of fluid motion and pressure.

179. The student will draw a diagram of an airfoil and label the resulting pressures produced in flight according to Bernoulli's Law.

180. The student will define induced and dynamic lift.

181. Given a four by ten inch rectangular piece of paper, the student will produce an application of Bernoulli's Law by blowing across the top of the paper lengthwise.

182. The student will define relative wind.

183. The student will draw a diagram of the resulting path of a ball thrown out of a car travelling at 50 m.p.h. with reference to a particular fixed point.

184. Given 10 examples of two vehicles travelling in opposite or parallel directions, the student will compute the relative velocites of the two vehicles.

185. The student will define a problem and then design a related experiment investigating the principles of flight.

186. The student will build a wind tunnel and demonstrate its use.

187. The student will define the terms airfoil, chord, camber, leading edge, and trailing edge.

188. Given a Delta Dart kit (or equivalent) the student will build and fly a rubber-band powered model airplane.

189. The student will name the three axes of motion.

190. The student will identify the three basic motions of an aircraft in flight.

191. The student will define the terms roll, pitch, yaw, longitudinal, horizontal, lateral, and vertical in relation to the three basic motions of flight and axes of rotation.

192. The student will name the four basic control surfaces of an airplane.

193. Shown a figure or picture of a standard airplane, the student will label the flaps, ailerons, elevator, and rudder.

194. Given a balsa glider kit, aluminum foil, scissors, and glue, the student will construct a balsa glider and then attach movable control surfaces (elevator, rudder, flaps, and ailerons) using aluminum foil.

195. The student will make a table of basic control surface positions (left, right, up, down) and then test the effect of each position using a balsa glider with movable control surfaces. The student will record the observed results of each test flight on the table.

196. The student will compare experimental results with at least four other students and then, based upon the collected data, write a summary of conclusions on the effect of individual control surfaces on the attitude of airplanes.

197. Given a table of experimental results and the model gliders from which the results were obtained, the student will select that model which produced results closest to expected control surface effects.

198. Given a table of experimental results and the model gliders from which the results were obtained, the student will examine each model that deviated from expected performance and describe what part of its design structure produced the deviation.

199. Shown a model of an airplane with movable control surfaces (flaps, ailerons, rudder, and elevator), the student will describe the resulting change in attitude of the plane as each control surface is moved individually and in coordination with other surfaces.

200. Given a model airplane with movable control surfaces, the student will position the control surfaces to simulate the following motions of an airplane: climbing, diving, yawing (right and left), turning (right and left), and banking (right and left).

Airplane Parts, Instruments, and Navigation

201. Shown a figure of a standard airplane, the student will label the following parts: propeller, fuselage, landing gear, left wing, right wing, horizontal stabilizer, vertical stabilizer (dorsal fin), flaps, ailerons, rudder, elevator, strut, landing lights, rotating beacon, and trim tab.

202. The student will make a list of at least ten devices for each of the following principles of operation: electrical, pressure, and mechanical.

203. Given a list of common household appliances and other devices, the student will classify them as to their principle of operation--electrical, pressure, or mechanical.

204. The student will define the term "avionics."

205. Given a list of airplane instruments the student will classify them as navigation, flight, or engine instruments.

206. Given a list of basic airplane instruments and a list of basic automobile instruments the student will match the two lists as to similarity of function or purpose.

207. Shown a diagram of a general aircraft instrument panel the student will name the instruments indicated.

208. The student will draw a figure and label the four instruments found in the basic "T" of an airplane instrument panel.

209. Given 15 cut-out figures of airplane instruments the student will arrange and paste them on an outline of an instrument panel in the usual cockpit arrangement.

210. Given a list of airplane instruments the student will write a description of the purpose and/or function of each instrument.

211. The student will name the instrument or control that indicates or produces each of the following phenomena of an airplane in flight: altitude, amount of fuel, attitude of the plane, turn angle, time, engine r.p.m., engine oil pressure, increases engine speed, indicates how fast plane is diving or climbing, speed of plane through the air, direction of flight, direction of a turn, weather information, makes plane dive or climb, direction of a locator beacon, and communication by voice.

212. The student will construct a table listing the related axis of motion, control surface(s), and instruments for each of the following aircraft motions: climb, dive, takeoff, landing, left bank, right bank, roll, yaw left, yaw right, left turn, and right turn.

213. Presented with specific changes of attitude or motion of an airplane the student will describe the motion in terms of axis of motion, control surfaces that produce each change, and what instruments are affected by each change in attitude or motion.

214. Given pictures or diagrams of airplane instruments (including an artificial horizon, altimeter, turn and bank indicator, vertical speed indicator, airspeed indicator, compass, and clock), the student will describe the attitude or condition of the plane in flight as indicated by each instrument shown.

215. The student will convert knots to miles and miles to knots.

216. Given a compass the student will write the number of degrees corresponding to each of the following directions: N, S, E, W, NW, NE, SE, SW.

217. Given pictures or diagrams of an airplane magnetic compass the student will read and write the indicated compass heading in degrees and the direction of each compass pictured.

218. The student will define longitude, latitude, equator, prime meridian, and coordinate.

219. The student will write the longitude and latitude of his/her home city.

220. Given ten locations on earth the student will list the longitude and latitude of each location.

221. The student will define the terms relief, cultural and hydrographic as related to features depicted on an aeronautical sectional chart.

222. Given an aeronautical sectional chart and a list of features the student will classify the features as relief, hydrographic, or cultural.

223. Given an aircraft navigational chart and a corresponding legend the student will write the chart coordinates of 20 indicated ground features (including such features as airports, highway intersections, rivers, lakes, mountain peaks, railroad tracks, towns, radio/TV towers, and navigational aids).

224. The student will define the terms airway, controlled airspace, prohibited airspace, restricted airspace, warning airspace, alert airspace, and Continental Control Area.

225. The student will define the terms pilotage, dead reckoning, flight plan, VFR, IFR, and celestial navigation.

226. The student will describe how radio communication is used between a pilot and each of the following: a control tower, ground control, flight service station, and other airplanes.

227. The student will describe each of the following navigation aids and how each is used: omni range stations (VOR), distance measuring equipment (DME), automatic direction finders (ADF), instrument landing system (ILS), air traffic control centers (ATCC), and RADAR.

Aviation Classifications and Uses

228. The student will brainstorm and list as many uses of aircraft as possible within a 10 minute time limit.

229. The student will define the two major classes of aircraft uses--military and civil.

230. The student will list the six categories of military aircraft.

231. The student will name two aircraft used in each of the six categories of military aircraft.

232. Given a set of military aircraft prefix letters, the student will designate the type or mission of each aircraft.

233. The student will list the uses of the high-altitude U-2 and SR-71 Blackbird.

234. The student will describe aerodynamic and ballistic missiles.

235. The student will identify and describe the SSM, SAM, AAM, and ASM categories of military missiles.

236. The student will define the three classes of Civil Aviation--general, air carrier, and government.

237. The student will distinguish among air carrier, general, and government aviation.

238. The student will define the term air carrier.

239. The student will name the seven categories of air carriers.

240. The student will describe the seven categories of air carriers.

241. The student will list ten common air carriers.

242. The student will name an airline company in each of the seven air carrier categories.

243. Shown a picture, model, or diagram the student will identify each of the following: Boeing 707, 727, 737, 747, 757, and 767, Douglas DC-8, DC-9, and DC-10, Lockheed L1011, and British A-300B.

244. The student will describe the role of the FAA and CAB in air carrier operation.

245. The student will define short, medium, and long commercial air routes.

246. The student will list those types of transportation systems considered to be common carriers.

247. Given the origin, destination, and type of cargo the student will chose truck, rail, steamship, or air transport as the most efficient means of delivery for each of ten shipments.

248. The student will define General Aviation.

249. The student will name and describe the four classes of General Aviation.

250. The student will describe the two major subgroups of general commercial aviation.

251. The student will list at least five non-transportation commercial uses of general aviation aircraft.

252. The student will define VTOL, STOL, and V/STOL.

253. The student will make a list of uses for a personal automobile and a comparative list for a personal airplane.

254. The student will name the big three U.S. automobile and the big three general aviation aircraft manufacturers.

255. The student will describe a specific use of a Boeing 707 as a military, government, air carrier, and general aviation aircraft.

256. The student will list at least five specific types or levels of aircraft pilots licenses.

257. The student will report in writing the sensation of flying following a flight in a small general aviation aircraft.

258. The student will write an observation report following a visit to an FAA control tower.

259. The student will write an observation report following a visit to an FAA Air Traffic Control Center.

260. Following a tour of a major international airport, the student will draw a diagram of the airport's lay-out.

261. The student will make a film showing the activities at an airport.

262. The student will identify the following: USAF, USN, V/STOL, FAA, CAB, CAP, ICBM, AWACS, DOD, DEW, NOAA, NATO, U.N., and SAC as related to aviation.

The Solar System and Universe

263. The student will define interplanetary, interstellar and cislunar space.

264. The student will describe the chemical composition of the sun.

265. The student will state the approximate surface and core temperatures of the sun.

266. The student will classify the sun as to size and type of star.

267. The student will state the approximate age of the sun and describe the predicted stages of its life.

268. The student will describe the location, size, composition, and characteristics of the sun.

269. The student will define the terms corona, chromosphere, sun spot, solar wind, and solar energy.

270. The student will define the terms apogee, perigee, aphelion, perihelion, apoapsis, and periapsis.

271. The student will define the term revolution and describe the way that the earth orbits the sun.

272. The student will define the term leap year and explain its cause.

273. The student will identify the term rotation and explain how it causes day and night.

274. The student will describe the angle of inclination of the earth and its affect on the earth's seasons.

275. The student will describe the affect of the moon and sun on the earth's tides.

276. The student will describe the way in which the moon revolves around the earth and turns on its axis and the resulting relative position of the moon to earth.

277. The student will draw a diagram of the stages of a total lunar eclipse including the positions of the sun, moon, and earth.

278. The student will draw a diagram of the stages of a total solar eclipse including the positions of the sun, moon, earth, penumbra, and umbra.

279. The student will list at least ten phenomena found in cislunar space.

280. The student will describe the three major theories of the origin of the moon and which theory seems most plausible.

281. The student will compile a list of song titles containing the word "moon."

282. The student will compile a table of data about the moon including diameter, circumference, orbit velocity, length of orbit, period of orbit, approximate age, surface temperature range, distance from earth at perigee and apogee, and mean distance from earth.

283. The student will list at least five things that strike the moon's surface.

284. The student will state two possible explanations for the existence of moon craters and "moondust."

285. The student will define and describe each of the following: cosmic rays, "shooting star," meteors, meteoroids, meteorites, micrometeorites, comets, asteroids, planetoids, and natural planetary satellites (moons).

286. The student will name the first five asteroids and the year each was discovered.

287. The student will describe the three major theories of how asteroids were formed.

288. The student will describe two possible origins of meteoroids.

289. The student will name the planets in order of position.

290. The student will name the planets in order of size.

291. Given a diagram or a model of the solar system the student will name the planets in order from the sun and identify relative sizes and revolution time.

292. The student will convert astronomical units to miles and vise versa.

293. The student will express the solar distance of each planet in astronomical units.

294. The student will convert miles to kilometers and vice versa.

295. Given detailed pictures (either actual photographs or drawings) of the explored planets, the student will name each planet shown.

296. The student will classify the planets as terrestrial or gaseous.

297. The student will classify the planets as inner or outer planets.

298. The student will compile a table of data listing the circumference, diameter, distance from the sun, number of moons, surface temperature range, most common element, type of atmosphere, surface features, and one unique characteristic of each of the planets.

299. The student will make a bar graph showing the relative weight of an object (possibly the student's own weight) on each planet.

300. The student will make a sketch of each planet showing the position of the poles relative to the plane of orbit and labeling the angle of inclination.

301. The student will explain the origin of the names of each of the planets.

302. The student will describe the "greenhouse effect" on Venus.

303. The student will describe the Valley of the Mariner, Nix Olympica, soil composition and color, wind velocity, and atmospheric conditions on Mars.

304. The student will present evidence for the theory that Jupiter is a companion star to the sun.

305. The student will list two natural phenomena found only around Jupiter and Earth.

306. The student will describe the events that led to the discovery of the rings of Uranus.

307. The student will describe the events that led to the discovery of the planet Pluto.

308. Based on the physical characteristics of each planet in our solar system, including temperature range, surface features, atmospheric composition, chemical composition, gravity, size, distance from the sun, and any unique feature, the student will draw a picture of what a being from each planet might look like.

309. The student will make a table of natural satellites including name, planet, size, atmosphere, shape and surface features.

310. The student will briefly describe the contribution to astronomy made by each of the following: Pythagoras, Archimedes, Hipparchus, Anaxagoras, Aristotle, Eratosthenes, Galileo, Isaac Newton, William Herschel, Tycho Brahe, Copernicus, Kepler, Bruno, Huygens, George Hale, Ptolemy, Joseph von Fraunhofer, Michael Faraday, Kirchhoff, Foucault, and Albert Einstein.

311. The student will define the terms astronomical unit, light-year, and parsec.

312. The student will convert light years to miles and vice versa.

313. The student will list the types of stars and their distinguishing characteristics.

314. The student will prepare a table listing the color and corresponding surface temperature of stars.

315. The student will describe the methods used for naming and cataloguing stars.

316. The student will describe the stages in the life of a star.

317. The student will define the term constellation and explain the probable origin of stellar constellations as viewed by man.

318. Shown a picture or diagram of a common constellation the student will name it and trace its outline.

319. The student will explain the apparent motion of the stars in terms of the earth's axis, rotation, and Polaris.

320. The student will find his approximate latitude using a protractor and sighting the star Polaris.

321. The student will describe the three types of galaxies--spiral, irregular, and elliptical.

322. The student will make a sketch of the Milky Way and locate the approximate position of our sun and solar system.

323. The student will state the velocities of the earth's rotation (equatorial), earth's revolution about the sun, the solar system's revolution about the galactic center and the time it takes the solar system to make one revolution.

324. The student will define binary star, nova, supernova, neutron star, pulsar, red giant, white dwarf, and black hole.

325. The student will describe and distinguish from one another stars, galaxies, constellations, pulsars, quasars, nebulae, and black holes.

326. The student will describe the big bang, expanding universe, steady state, and pulsating universe theories.

Space Exploration

327. The student will define the terms velocity, escape velocity, orbital velocity, terminal velocity, acceleration, and speed-of-light.

328. The student will list the four basic parts of rockets and missiles.

329. Using an Estes Alpha (or equivalent) model rocket kit the student will build and launch a model rocket.

330. The student will build a model rocket launch pad.

331. The student will list the model rocketry safety rules.

332. The student will describe how a rocket is launched in relation to Newton's three laws of motion.

333. The student will define the terms center of gravity and center of pressure.

334. The student will explain the difference between sounding rockets and space boosters.

335. The student will identify and describe vehicles used for space travel.

336. The student will describe the scientific principle of how a satellite stays in orbit.

337. The student will define sunsynchronous, polar, equatorial, geostationary, Clarke, geosynchronous, transfer, and parking orbits.

338. The student will list the advantages of near earth, geosynchronous, and polar orbits.

339. The student will list the six types of man-made earth satellites.

340. The student will describe at least ten applications of LANDSAT images.

341. The student will build a model satellite of his/her own design.

342. Given the activity "Down on the Moon" the student will rank the items individually and then as a member of a group and make a comparison of the two rankings with the suggested expert ranking by NASA. From the results the student will state a conclusion about individual versus group decision-making.

343. The student will make a list of features he/she would like to know about before landing a spacecraft on an unexplored planet.

344. The student will describe fly-by, orbiter, probe, and lander space exploration vehicles.

345. The student will name the solar system bodies on which man-made spacecraft have landed.

346. The student will make a table listing which planets have been explored by fly-by, orbiter, probe, and lander spacecraft.

347. The student will name and describe each of the missions to Mars.

348. The student will summarize the purpose, duration, and results of the Viking missions to Mars.

349. Given the coordinates of the Apollo lunar landing sites and of the Martian Viking landing sites the student will plot the corresponding locations on a map of the earth.

350. Using the locations on Earth as determined by the Apollo lunar and Viking Martian landing site coordinates the student will write a description of each Earth location including surface features, altitude, approximate temperature range, general climate, and possible life forms.

351. Based only on the data from the descriptions of the earth locations corresponding to the Apollo and Viking landing sites, and as if he/she were an alien investigating Earth, the student will formulate in writing a description (conclusion) of what life on the earth might be like.

352. The student will describe the Pioneer, Mariner, Viking, and Voyager series of planetary probes.

353. The student will name and state the date of the only man-made object to leave the solar system so far.

354. The student will describe the Space Telescope and its advantage over ground based telescopes.

355. The student will make a summary list of types of exploration planned for each planet in the next twenty years.

356. The student will describe the planned Galileo mission to Jupiter.

357. The student will identify VOIR and describe its planned mission to Venus.

358. The student will describe five ways that planetary exploration may provide information directly related to what happens on Earth.

359. The student will design and construct a delicate instrument planetary landing craft (a package that will protect a raw egg when dropped from a height of at least 50 feet). The total package must weigh no more than one pound, be no bigger than one cubic foot, and have no airfoil or drag (parachute) devices attached.

360. The student will describe at least five problems unique to manned space travel.

361. The student will describe at least three disadvantages of the near zero-gravity condition for man in space.

362. The student will describe at least three advantages of the near zero-gravity condition for man in space.

363. The student will name the four main parts of the Space Shuttle.

364. Given a picture or diagram of the space transportation system the student will label the orbiter, solid rocket boosters, external tank, and main propulsion engines.

365. Given a picture or diagram of the space shuttle orbiter the student will label the crew cabin, passenger compartment, cargo bay doors, vertical stabilizer, rudder/speed brake, elevons, body flap, main engines, orbital maneuvering engines, rear reaction control engines, forward reaction control engines, main landing gear, and nose landing gear.

366. The student will describe the intended purposes of the space transportation system (Space Shuttle).

367. The student will identify and describe the working features of the space shuttle's cargo bay.

368. The student will describe the Spacelab and its planned uses.

369. The student will list the advantages of building a permanent space station in earth orbit.

370. The student will draw a design for a permanent manned space station.

371. The student will write a description of a possible future space habitat, including residential, recreational, agricultural, manufacturing, and transportation facilities.

372. The student will describe Lagrange points L4 and L5.

373. The student will write a paper discussing the present and future uses of solar energy.

374. The student will list at least three ways that the following may change the way people live in the future: the Space Shuttle, computers, nuclear reactors, the ocean, and the moon.

375. The student will design a future space business including company name, logo, motto, service or product provided, needed resources, and number and skills of employees.

376. The student will write a play about a rescue in space.

377. The student will write a scenario of man's activity in the space environment in the years 1990 and 2000. The scenario will include descriptions of spacecraft, space structures, specific activities, numbers of people in space, and other pertinent projections.

378. Given the scenario that man has established colonies on the moon and in orbits around Venus and Mars, that construction resources are becoming scarce and that a meeting of the leaders of resource developing colonies is taking place, the student will write a newspaper article discussing "the asteriod shortage of 2085."

379. The student will write a paper discussing the future of space travel.

380. The student will write a paper discussing his/her opinion of why man should or should not devote resources to space exploration.

381. The student will participate in a debate defending one of the points of view for or against man's exploration of space.

382. The student will identify each of the following: NASA, RTG, RPV, AU, STS, JPL, ESA, NAR, EVA, OMS, and SRB.

Aerospace Careers and Awareness

383. The student will write a definition of "aerospace" in his/her own words.

384. The student will define where the atmosphere ends and space begins.

385. The student will design and construct a display of newspaper articles relating to aerospace topics for a period of one week. The display must show some system of categorization and include a legend and necessary explanatory material.

386. The student will read and then write a review of an article in a current magazine, newspaper, or other publication. The review will include the title and author of the article, name and issue of the publication, a summary of the article, and a student evaluation (critique) of the article.

387. Using the format as taught in language arts classes the student will read and write a report about a book having an aerospace theme.

388. Using correct business letter format the student will write a letter requesting information about an aerospace question or topic of his/her choice. The letter will be addressed to an appropriate individual, company, or other areospace organization as determined by mutual agreement of the student and teacher.

389. The student will write a series of questions, plan, and conduct an interview with a person who works in the aerospace field.

390. The student will compile a list of all the occupations needed to operate a major international airport.

391. The student will select an aerospace occupation and write a job description including duties, physical and health requirements, education and training requirements, working hours, working conditions, salary, and unique or special job characteristics or requirements.

392. Given a sample job application the student will complete the application as if applying for a job.

393. The student will compare and contrast the attitudes and reactions of the general public, press, business, and government (including military) to the following inventions following their first successful demonstration: automobile, aeroplane, balloon, steam engine, steamboat, telephone, space shuttle, electric light, and printing press.

394. The student will write a poem about flying, space travel, or the future.

395. The student will present evidence for labeling our current era each of the following: Space Age, Aerospace Age, Computer Age, Age of Technology, Communication Age, Electronic Age, and Information Age.

396. The student will make a list of at least three ways that each of the following has influenced or changed the way people live: automobile, refrigerators, TV, radio, airplane, telephone, computer, transistor, satellite, micro-chip, and rockets and missiles.

397. The student will explain what he/she believes are the three most important inventions of the twentieth century.

398. The student will make a list of spin-offs from space technology that have direct application to non-space activities for man on earth.

399. The student will design an aerospace project for a school science fair.

400. The student will write a multiple-choice test about a specific aerospace topic.

401. The student will program an objective test about an aerospace topic on a computer.

402. The student will make a list of songs that refer to flying or space travel.

403. The student will make a list of songs containing references to space pheonomena such as the sun, moon, stars, or planets.

The following objectives are written in the affective mode. They may be used to assess the attitude or interest of the student toward aerospace education. The objectives identify observable behavior that may be indicative of goals and objectives achieved in the affective domain.

404. The student voluntarily brings in newspaper or other articles about aerospace.

405. The student shares during class discussion a personal experience about flying or other aerospace activity.

406. The student asks for other sources of information about an aerospace topic he/she wishes to pursue voluntarily.

407. The student enrolls in the summer Space Camp at Maxwell Air Force Base, Alabama.

408. The student takes private flying lessons.

409. The student volunteers to invite a friend or relative as a guest speaker.

410. The student writes to an aerospace source to personally receive more information about an aerospace topic.

411. The student chooses an aerospace topic for a required project in another class.

412. The student enrolls in an advanced aerospace class.

413. The student collects models of aerospace vehicles.

414. The student voluntarily reads additional books and other print material about aerospace subjects.

415. The student chooses aerospace subjects as the topic for assignments in other classes.

416. The student expresses a desire to pursue an aerospace career.

417. The student demonstrates knowledge of aerospace topics and facts beyond the scope of materials presented in class.

418. The student expresses a desire to learn more about a particular aerospace topic.

419. The student joins the Civil Air Patrol cadet program or other aerospace organization.

Adapting Objectives to Bloom's Hierarchy

Most objectives may be written on any level of Bloom's taxonomy. The objectives in this project may be modified or rewritten to produce learning at the desired level. Following is an example of the hierarchy that may be developed for one concept, in this case, control surfaces of airplanes.

Level	Objective
Knowledge:	Shown a figure or picture of a standard airplane, the student will label the following: flaps, ailerons, elevator, and rudder.
Comprehension:	Shown a model of an airplane with movable control surfaces (flaps, ailerons, elevator, rudder), the student will describe the resulting change in attitude of the plane as each control surface is moved individually and in coordination with other surfaces.
Application:	Given a balsa glider kit, aluminum foil, scissors and glue, the student will construct a balsa glider and then attach movable control surfaces (elevator, rudder, flaps, ailerons) using aluminum foil.
Analysis:	The student will make a table of basic control surface positions (left, right, up, down) and then test the effect of each position using a balsa glider with movable control surfaces. The student will record the observed results of each test flight on the table.
Synthesis:	The student will compare experimental results with at least four other students and then, based upon the collected data, write a summary of conclusions on the effect of individual control surfaces on the attitude of airplanes.
Evaluation:	Given a table of experimental results and the model gliders from which the results were obtained, the student will select that model which produced results closest to expected control surface effects.

Cross-referenced Categories

Many of the objectives belong to more than one category. Aerospace history objectives concerning dirigibles, for example, could also be classified under lighter-than-air craft. Because the objectives are interrelated among categories, a cross-referenced listing is presented below for use in planning specific units of instruction.

Category: Objectives from other categories

Aerospace History (1-147): 155, 161-62, 165, 167, 172, 230-31, 233-35, 244, 254, 262, 267, 286, 306-307, 310, 345-53, 383, 393, 395-406, 409-19

Lighter-than-air and Unpowered Aircraft (148-72): 1-4, 10-18, 20, 23-29, 30-32, 40, 86-88, 103, 135-39, 142, 144, 173-86, 385-88, 394, 398-402, 404-406, 408-19

Principles of Flight and Control (173-200): 6-7, 21, 30, 39, 212-14, 327, 332-33, 385-88, 394, 398-401, 404-19

Airplane Parts, Instruments and Navigation (201-227): 42, 187-88, 192-94, 328, 363-65, 367, 385-88, 394, 404-406, 408-15, 417-19

Aviation Classifications and Uses (228-62): 16, 21, 23, 29, 35, 44, 46-47, 53-58, 68, 69, 74-88, 91, 113-15, 123-24, 140-41, 166-68, 170, 172, 366, 374-75, 385, 406, 408-19

The Solar System and Universe (263-326): 342-59, 372-73, 378, 384-88, 399-404, 410-12, 414-15, 417-19

Space Exploration (327-82): 5, 69, 118-22, 125-32, 135-39, 142, 145-47, 171, 286, 303, 306-307, 310, 315, 385-88, 393-407, 409-419

Aerospace Careers and Awareness (383-419): 170, 247, 253-54, 256, 335-46, 354-62, 368-81

Interdisciplinary Study

Many aerospace topics and activities are interrelated to other areas of human endeavor. Much aerospace education may be achieved through interdisciplinary study. Following is a list of objectives cross-referenced to traditional junior high curriculum subjects.

Subject: Objectives

Arts/Crafts: 148-52, 157-58, 169, 186, 188, 308, 329-30, 341, 359, 385, 411, 415

Geography: 60-61, 134, 143, 215-23, 339-40, 349-51, 411, 415

History/Social Studies: 1-147, 155, 165, 244, 310, 375, 377-82, 390-93, 395-98, 411, 415

Language Arts: 1-2, 4, 9, 64, 66, 73, 161-62, 261, 342, 376, 385-89, 391-94, 411, 415

Mathematics: 148-52, 157, 183-84, 215-20, 282, 292-94, 299-300, 311-12, 320, 349, 411, 415

Music: 281, 402-403, 411, 415

Science/Health: 7, 12-14, 16-19, 30, 45, 159-60, 173-86, 189, 194-98, 234, 263-327, 332-33, 336-38, 340, 343-75, 384, 395-99, 407, 411, 415

A Suggested Semester Plan

Following is a suggested semester plan. It is presented only as a guide in developing a one semester aerospace class.

Weeks	Topics
1	Introduction, History to 1500, Kites
2	History to 1914, Lighter-than-air Craft
2	Principles of Flight and Control
2	Airplane Parts, History to 1958
2	Instruments and Navigation
2	Aviation Classifications and Uses, History to 1983
2	Solar System and Universe
3	Rockets, Satellites and Space Exploration
2	Careers and the Future

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CHAPTER FIVE

Summary, Conclusions, and Recommendations

Summary

In 1979 a grant was received from Educational Service District #113 for the development of a one semester aerospace class at Miller Junior High, Aberdeen, Washington. The 1977 Washington State Student Learning Objectives Law required that instructional objectives be written for all courses offered by Washington public schools. Few junior high aerospace classes existed.

The literature indicated that while some research regarding aerospace education had taken place, no serious attempt had been made to develop behavioral objectives for a junior high aerospace course per se. The one exception was the listing found in the Civil Air Patrol cadet text, Aerospace '81. Most science curriculum guides contained only limited study of aerospace topics, such as meteorology, astronomy and principles of motion. Teachers generally lacked both the time and expertise for writing appropriate objectives.

Instructional objectives were written for a one semester introductory junior high aerospace class. The objectives were then categorized under the headings: Aerospace History, Lighter-than-air and Unpowered Aircraft, Principles of Flight and Control, Airplane Parts, Instruments and Navigation, Aviation Classifications and Uses, The Solar System and Universe, Space Exploration and Aerospace Careers and Awareness. Objectives were also cross-referenced among topic areas for unit study. Some effort was made to classify objectives by academic discipline to allow for an interdisciplinary integration of aerospace topics into the traditional curriculum. An example of adapting an objective to the various levels of Bloom's Taxonomy was also presented.

Conclusions

Aerospace activities have been an integral and influential part of the history of the United States and the world, especially in the twentieth century. The concern with the decline of science and math education, the significant impact of aerospace technology on society, and the potential for aerospace activities to provide the knowledge and resources for solving many existing problems dictated an increased emphasis on aerospace education. With so few existing programs and few qualified aerospace teachers some attempt had to be made to more clearly define aerospace education objectives.

The primary goal of the project was to create awareness and some rudimentary knowledge of the aerospace activities. While the number and scope of the objectives may be broad enough for planning an introductory aerospace class, some areas need further development. The objectives written for this project may become outdated or of limited use as new areas of aerospace are developed. The objectives written in the affective domain may be too few to assess significant development of appreciation, interest, and positive attitudes regarding aerospace education.

Recommendations

Schools should establish as a curriculum goal the awareness of aerospace activity and minimum competencies in terms of basic scientific principles, historical events and influences, technological applications, future trends, and career awareness. Individual teachers, schools, and school districts should have access to these objectives through the Superintendent of Public Instruction and Educational Service Districts. Teachers are encouraged to revise, delete, and/or add to the list of objectives as fits their needs. More student participation should also be encouraged in setting goals and designing student learning activities.

A more thorough development of specific aerospace learning activities needs to be made for all levels of education. A junior high curriculum guide should be a next step in developing a more comprehensive aerospace education program. Interdisciplinary integration of aerospace and modern technology needs to be addressed as schools revise and improve curriculum. More advanced courses or units of study need to be developed for those students who wish to pursue further aerospace education. Using aerospace as a theme may attract more students to the study of science and technology.

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