

**AN INTERDISCIPLINARY CURRICULUM TO BE TAUGHT IN A BLOCK  
SCHEDULE FOR AT-RISK STUDENTS**

by

**William Edward Faint**

**A Master's Research Project Submitted in Partial Fulfillment  
of the Requirements for the Degree**

**Master of Arts**

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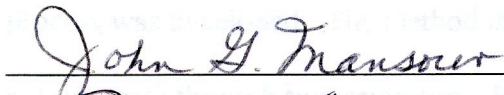
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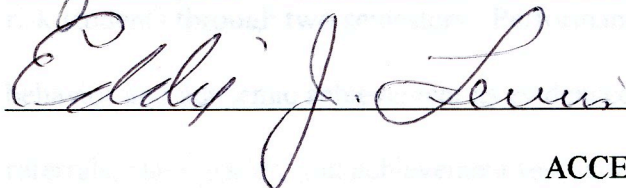
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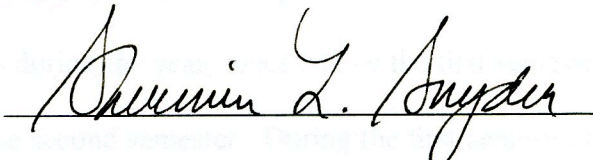
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## ABSTRACT

The purpose of this study was to propose an interdisciplinary curriculum to be taught within a block schedule aimed at benefiting at-risk students. The curriculum, entitled Science and Civilization, was developed to address the needs of the growing number of at-risk students in the Gilbert School District.

The study asked the following question: Would such a curriculum be effective? In order to answer this question, existing research was investigated. The literature investigated pertained to the effectiveness of block scheduling and interdisciplinary teaching, independent of each other. The assumption was made that if the two approaches were effective independent of each other, then a combination of the approaches would also be effective.

A method for evaluating the curriculum's effectiveness during the implementation process was developed. The method involved tracking the performance of a group of at-risk students through two semesters. Performance would be measured by students' behavior and academic achievement as evidenced by statistics on attendance, behavior referrals, class grades, and achievement test scores. The Metropolitan Achievement Test (MAT) would be administered three times during the year; once before the first semester, once between semesters, and once after the second semester. During the first semester the group of students would be enrolled in traditional history and science

classes within a traditional schedule. During the second semester the same group of students would enroll in the proposed curriculum within a block schedule. The group of students would have the same teacher for both semesters. It was assumed that any increase in the students' performance between the first and second semesters could be attributed to the new curriculum within a block schedule.

The curriculum is currently being proposed by the researcher as a future course offering in the Gilbert School District, and has been considered favorably thus far by the administration.

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# CHAPTER 1

## THE PROBLEM

### INTRODUCTION

As more of the student population is considered at-risk, teachers, administrators and school boards are searching for ways to make a difference and salvage the education of troubled youth. One approach which may hold some promise for this ever increasing population of students is the marriage of two particular teaching strategies. Independent of one another, both block scheduling and interdisciplinary teaching show signs of benefiting at-risk students. If the two strategies are combined, they may result in an even more effective approach than either strategy when utilized alone.

### DEVELOPMENT OF THE PROBLEM

The researcher currently teaches ninth grade General Science at Highland High School in the Gilbert School District. Gilbert is a district whose student population is becoming large very rapidly. Many new schools have been built to accommodate the increasing number of students, and more schools are currently being constructed. At the high school level, two new schools have been built within a seven year period, and a third is slated to open in the Fall of 1998. Each high school has a capacity of roughly 3,000 students.

As the student population continues to grow at such a furious pace, the number of



at-risk students is increasing as well. At the secondary level (grades seven through twelve) the increase in the number of at-risk students has been evidenced by the enrollment in the district's A.C.E. program. A.C.E. is an alternative education program which was created to meet the needs of those students who are the most at-risk of failing and/or dropping out of a traditional school setting. Students are enrolled in A.C.E. when their academic achievement and/or behavior is so severe that it precludes their ability to function in a traditional setting. According to statistics provided by the district (1997), the enrollment in A.C.E. from the years of 1993/94 to 1996/97 steadily increased. During the 1993/94 school year thirty-eight students were enrolled in the program. In 1994/95 the enrollment rose to eighty-one. During the 1995/96 school year, enrollment climbed to 112. By 1996/97 the enrollment in the program reached 163. Since only students at the greatest risk are enrolled in the program, it could be assumed that many more students are at-risk within the district. In any case, these statistics indicate a rapid growth in the at-risk population at the secondary level within the district.

## NEED FOR THE STUDY

The rapid increase in the number of at-risk students in the Gilbert District has created a need to find ways to serve these students. Traditional means of serving at-risk students, such as counseling and life skills/responsibility type curriculums, continue to be utilized within the district. However, rather than relying solely on these traditional methods, the researcher has been prompted to search for new ways to meet the needs of the growing at-risk population.

## PURPOSE OF THE STUDY

The purpose of this study was to develop an interdisciplinary curriculum to be taught within a block schedule format that would benefit at-risk students. The proposed course, entitled Science and Civilization, is a combination science/history class where the interrelation between scientific discovery and the rise of civilization is studied. The course would be taught for one year, and would be aimed at ninth grade students.

## RESEARCH QUESTION

In order to determine the appropriateness of this curriculum, the following question was asked: Would such a curriculum be effective? This question directed the investigation into the existing body of research, and guided the design for implementation and evaluation of the curriculum.

## DEFINITION OF TERMS

Before addressing the research question, it was necessary to first define the terms interdisciplinary teaching, block scheduling, at-risk, and effectiveness.

### **Interdisciplinary Teaching**

Fitch defines interdisciplinary teaching as "teaching . . . that correlates or integrates topics from two or more different disciplines to reinforce and increase student learning" (1991, 7). Some combinations that have been used include English and social studies, and math and science, since these disciplines are closely related and readily



reinforce each other. The premise for interdisciplinary teaching is that by exploring different disciplines concurrently, students will be able to see meaningful connections between them. The hope is that learning will be more relevant, that students will learn to synthesize information on their own, and learn to look for the connections between seemingly unrelated topics (Jacobs 1989).

### **Block Scheduling**

The term block schedule refers to a fundamentally different type of schedule compared to the traditional school schedule. Normally, schools operate within a schedule where students attend seven different classes a day for approximately fifty minutes each class period. To earn one credit in a given discipline, a student must attend class for two ninety-day semesters. This unit of credit is termed the Carnegie unit, and is the basis for the traditional ways in which schools operate (Carroll 1994). By contrast, block schedules typically double the length of each class period and cut the number of classes attended per day in half. The number of days required to achieve the same amount of course credit is compressed, and students and teachers are allowed to concentrate on fewer subjects at a time.

The schedule change is not an end in itself but rather a means to create a classroom environment that fosters vastly improved relationships between teachers and students and that provides much more manageable workloads for both teachers and students. In theory, the outcome should be schools that are more successful. (Carroll 1994, 106)

## **At-Risk**

Vandegrift and Greene (1992) give the following definition for at-risk: "Students at-risk are those whose life circumstances . . . often are associated with low achievement, behavioral problems, low self-esteem and other factors making them more likely to fail in school and drop out" (Vandegrift and Greene 1992, 1). Due to various personal, social, emotional and/or family problems a student may be in danger of missing his or her educational opportunities. This risk of forfeiting one's education may be characterized by poor attendance, an increase in discipline problems, failing class grades, and ultimately dropping out of school altogether.

## **Effectiveness**

Since the goal of the proposed curriculum is to benefit at-risk students, its effectiveness must be evaluated according to how well it addresses characteristic at-risk problems. Therefore, in this study, effectiveness is measured by the impact of the curriculum on students' attendance, discipline, class grades, achievement on standardized tests, drop out rate, and rapport with the teacher.

## CHAPTER 2

### THE LITERATURE REVIEW

#### INTRODUCTION

In order to judge the potential effectiveness of the proposed curriculum, the effectiveness of its constituent parts (block scheduling and interdisciplinary teaching) were investigated independent of each another. The research that has already been done regarding the effectiveness of block scheduling was investigated, as well as the research concerning the effectiveness of interdisciplinary teaching.

#### EFFECTIVENESS OF BLOCK SCHEDULING

In a study which examined the effectiveness of block scheduling at Governor Thomas Johnson High School in Fredrick, Maryland, Guskey and Kifer (1995) detailed the change during the 1992-93 school year to a block schedule. The former schedule utilized the traditional format of seven forty-eight minute periods. The new block schedule consisted of four ninety-minute periods. Each semester lasted the traditional eighteen weeks, but courses normally lasting two semesters were compressed into one. The results of the change were that attendance, drop out rate and class grades were relatively unchanged, as were most students' scores on the Fredrick County Summative Tests and Maryland functional tests. However, the scores of African-American students on the Maryland functional tests went up in each category (reading, mathematics, writing



and citizenship). Their scores increased dramatically in the categories of mathematics and citizenship (+20.5% and +21.3% respectively). There was also a decrease in the number of office referrals for African-American students. "Overall, the Block Schedule Program appears to provide distinct advantages to African-American students" (Guskey and Kifer 1995, 13).

Behavior also improved dramatically for the entire student body. The evidence on disciplinary actions indicate that student behavior has improved dramatically with the introduction of the Block Schedule Program. While the number of suspensions remained unchanged, the number of referrals to the office decreased by 20%, and for ninth graders, the group which traditionally accumulates the greatest number of referrals, the rate was reduced by 30% (Guskey and Kifer 1995, 12).

When interviewed, students stated that they felt their teachers were able to give them more individualized attention, and that they had more opportunities to participate (Guskey and Kifer 1995).

An experimental block schedule at Benjamin Russell High School in Alexander City, Alabama, was evaluated by Spencer and Lowe (1994). Four classes of ninth graders were placed in a Copernican schedule in which classes are double their normal fifty-minute length. The program was evaluated by examining students' grades. The findings of the study showed that students' grades stayed the same in mathematics, science, and Alabama history/world geography but increased in English literature when compared to students in the traditional schedule. "Students taught in the extended blocks achieved higher final grades than their cohorts who took the regular section" (Spencer and Lowe 1994, 4). The impact of the new schedule was positive, but the researchers said that a greater variety of evaluation methods should have been used. "Were we to use different measures of

student achievement, measures such as standardized test scores, the results might be different" (Spencer and Lowe 1994, 6).

Carroll (1994) details the evaluations of eight schools operating under the Copernican Plan. The schools studied were not "choice" schools, and that all but one had adopted the new schedule school-wide. "The schedule changed, but the socioeconomic backgrounds of the students did not. In the school-within-a-school program, 58% of the participating students had been previously identified as 'at-risk'" (Carroll 1994, 110). The results of the plan's application in these schools were positive. Attendance improved moderately, and in the area of student conduct suspensions were reduced by a range of 25% to 75% during the first year under the plan. There was significant improvement in dropout rates, with six schools reporting reductions ranging from 17% to 63%. Three of these six had serious retention problems previously, losing from 27% to more than 50% before graduation. Dropout rates in these three schools had been reduced by 63%, 58%, and 36%. Carroll (1994) points out that one traditional state dropout prevention program had reported only an 11% reduction after three years (Carroll 1994).

The reductions in suspension and dropout rates are educationally spectacular. They occur because the Copernican change improves the relationships between teachers and students and provides more manageable workloads for both. It appears that students who know their teachers and feel a part of their classes tend to be less disruptive and to stay in school. No "rocket science" here, just research findings being confirmed in practice. (Carroll 1994, 112)

Another advantage of the Copernican plan is that it enables schools to enroll transient students at the beginning of a semester more often than in a traditional schedule.

"With this kind of schedule, students do not begin classes far behind the other students, and they know that they can complete a full course if they can stay in school for forty-five, sixty, or ninety days; these are significant improvements for these at-risk students"

(Carroll 1994, 112). In the area of impact on academic performance, the schools posted increases that ranged from 0% to 46% with a median increase of 18%. These measures were arrived at by a combination of the number of courses completed by students and course grades. "In the cases of two high schools, the year-to-year results with regard to academic mastery were solidly confirmed by the year-to-year scores on strong state/provincial testing programs" (Carroll 1994, 112).

#### EFFECTIVENESS OF INTERDISCIPLINARY TEACHING

In the final report on Project Homeroom and Project Schoolroom at Maine East High School, Hecht (1994) describes the results of the implementation of this new interdisciplinary program. During the 1993-94 academic year, the freshman class was divided into three groups. The first group was named Project Homeroom and incorporated team planning, interdisciplinary teaching and heavy usage of computers, both in and out of school (students were given computers to take home for the duration of the year). This group was comprised of forty-eight students. The second group was similar to the first, and was given the name Project Schoolroom. It also utilized team planning and interdisciplinary teaching, but did not have the same access to computers that the students of Project Homeroom did. Instead, this group stressed that the teachers get to know their students better as a main feature. A total of fifty-six students was in this



group. The remaining 478 students stayed in the traditional school structure and were referred to as Regular School.

The program's effectiveness was measured on the basis of student achievement (scores on criterion referenced exams and course grades) and attendance. Each group's criterion referenced test (CRT) scores increased. In the area of grades, however, there were distinct differences.

Comparison of these averages revealed a pattern of students in the Project Schoolroom group consistently outperforming their Project Homeroom counterparts across every subject and in virtually every grading period. Project Homeroom students tended to likewise outperform their regular school counterparts, although not statistically different in every grading period. (Hecht 1994, 18)

Consequently, there were also differences in grade point averages, with Project Schoolroom students higher than both of their counterparts. The grade point average (GPA) of Project Homeroom students and Regular School students were statistically the same. In the area of absences, "Project Schoolroom students tended to be absent less, both excused and unexcused, than both their Project Homeroom and Regular School group counterparts" (Hecht 1994, 28).

During the 1982-83 school year, Hartman-Haas (1984) conducted a study in her own classrooms using a form of interdisciplinary teaching known as the Holistic Approach.

Holistic education is characterized by . . . implementing a multidisciplinary perspective and incorporating educationally relevant contexts into the instructional process . . . The hypothesis underlying this approach is that if students are taught holistically, they will develop a differentiated, refined, elaborated and interrelated structure of cognitive skills which will enable them to learn, retain, use and transfer their skills and knowledge better than if a discrete skills approach is used. (Hartman-Haas 1984, 2)

In order to measure differences in student performance between the traditional approach and the Holistic Approach, Hartman-Haas administered the Metropolitan Achievement Test (MAT) during the year before using the Holistic Approach, and the Comprehensive Tests of Basic Skills (CTBS) during the year she began using the Holistic Approach. According to test results, her seventh grade students' math and language achievement scores improved under the new approach (Hartman-Haas 1984). She also recorded her own observations on a regular basis and concluded that "the Holistic Approach also seems to be an effective strategy for increasing the degree of students' active participation in classroom activities" (Hartman-Haas 1984, 26).

## ADDITIONAL SUPPORTING LITERATURE

In addition to the primary research which was investigated, secondary literature was also explored. Though the following sources are not the product of original studies, they reflect the observations of several experienced authorities and relate to the effectiveness of block scheduling and interdisciplinary teaching.

### **Supporting Literature for Block Scheduling**

An article entitled "Unlocking the Lockstep High School Schedule" by Canady and Rettig (1993) summarizes some of the benefits of block scheduling which have been confirmed in other research. "By working with a smaller number of students each term, teachers have more opportunities to develop rapport and to identify student's strengths



and weaknesses...Conversely, students must adjust less frequently to their teachers' differing styles of instruction and classroom management" (Canady and Rettig 1993, 312). The possibility of immediate remediation has several advantages for the at-risk learner. Students who would normally be unable to attend summer school because of transportation expense can retake failed courses during the normal school year. This also averts the behavior problems that occur when a student realizes it is impossible for them to pass a class during their second term of a year-long course. They typically shut down and start misbehaving because they know they cannot retake the course and pass it until the following year or in the summer--and not even then if they cannot afford to provide their own transportation (Canady and Rettig 1993).

Ryan (1991), in his article entitled "Intensive Learning: An Answer to the Dropout Crisis" describes his own observations concerning the ineffectiveness of the traditional school schedule at improving absenteeism and reducing dropout rates. As a teacher at an inner city school in San Diego, which is comprised of nearly 95% minority students, he has witnessed a drop-out rate of 48 percent. "The overall district dropout rate among minority students (Hispanic 40 percent, and black 30 percent) defines a situation more or less replicated throughout the nation (Ryan 1991, 25)." As Ryan has considered ways to reach at-risk students, the success of intensive summer school programs with these students (75% pass rate) has served as a source of inspiration. While a summer school format is even more intensive than that of a block schedule (one class period a day for three weeks versus, for instance, three class periods a day for a semester), the point that Ryan makes is that the regular school year needs to be structured more intensively. He

concludes that if students were able to concentrate on fewer courses, with fewer adjustments for each teachers' expectations and styles, and if teachers could devote more individualized attention to fewer students, then students would have more success.

It would be reasonable to assume that more allocated time in school would actually be spent as engaged time on academics rather than constantly moving from classroom to classroom ... and having to adapt to five or six distinctive sets of teacher rules, personalities, and teaching styles each day. The chances of misunderstanding a teacher's instructions on an assignment or violating a rule of personal conduct in the class may also diminish ... Most important, the teacher provides the student with a meaningful role model for an extended period of time each day. An enhanced student to teacher relationship enriches the educational process (Ryan 1991, 29).

Although the format Ryan recommends is essentially a summer school format during the regular school year, the crucial principles which he advocates (fewer courses and extended class periods) are the same principles which govern block scheduling.

### **Supporting Literature for Interdisciplinary Teaching**

Dropout prevention specialist Ebert (1990) has had extensive experience with at-risk students as a result of her work in the RESA VII Dropout Prevention Program. She describes many tragic stories, and after stressing at length the need to reduce the number of dropouts in our schools, she makes several professional recommendations. Among these suggestions are the need for alternative learning programs for unsuccessful students and the use of interdisciplinary teaching.

## SUMMARY OF THE LITERATURE

In summary, the research indicates that the two components of the proposed curriculum, block scheduling and interdisciplinary teaching, are effective for at-risk students independent of each other. Block scheduling has proven in some cases to reduce the number of discipline referrals and suspensions, and lower the dropout rate. Block scheduling enables at-risk students to promptly retake courses which they have failed, thereby averting additional behavior problems and providing for immediate remediation. Under block scheduling, students have reported they have more opportunities to participate and engage in meaningful interaction with their teachers. Block scheduling also raises the levels of student achievement, both in the form of higher course grades and improved standardized test scores.

Likewise, the research pertaining to interdisciplinary teaching indicates that interdisciplinary teaching has been effective at raising students' class grades, and reducing absenteeism. Interdisciplinary teaching has also been shown in some cases to raise student achievement and levels of active participation in the classroom.



## CHAPTER 3

### METHODOLOGY

#### PURPOSE

The purpose of this study was to develop an interdisciplinary curriculum to be taught within a block schedule aimed at benefiting at-risk students. The research design was guided by the research question: Would such a curriculum be effective? A multi-faceted evaluation of the curriculum's effectiveness was developed in order to answer the research question.

#### RESEARCH DESIGN

##### **Introduction**

The literature review indicated that both block scheduling and interdisciplinary teaching are effective with at-risk students independent of each other. Block scheduling has been shown in many cases to increase student grades and achievement test scores, while reducing behavior problems, number of suspensions, and dropout rates. Block scheduling has also been shown to increase the amount of meaningful interactions students experience with their teachers, and increase the number of opportunities to actively participate in class activities.

Interdisciplinary teaching has been shown to increase student achievement and the degree of active participation by students in classroom activities. It has also been shown

to improve students' class grades and attendance. These improvements may be due in part to more positive student attitudes toward more interesting and relevant subject matter in their interdisciplinary classes. If students are more enthusiastic about their classes, they may be more likely to come to school consistently and achieve higher grades.

Since the literature indicated that interdisciplinary teaching and block scheduling are effective with at-risk students independent of each other, it was assumed that a curriculum which combines the two approaches would also be effective.

### **Evaluation During Implementation Process**

The evaluation of the curriculum's effectiveness during the implementation process would be performed as a controlled experiment, where variables other than the curriculum and schedule are held constant as much as possible. Variables which would be controlled include the teacher utilized, the composition of the student study group, and the length of the instructional day. The interdisciplinary curriculum within a block schedule would not actually be implemented until the second semester of the school year, due to the necessity to set up a comparison of student behavior and achievement between the first and second semesters.

During the first semester, a study group of twenty-five at-risk students would be enrolled in traditional science and history classes. The study group of students would be together in each of these classes, and the teacher for both the science and history classes would be the same.

During the second semester, the new interdisciplinary curriculum would be

implemented within a block schedule. The study group of students which had been enrolled in traditional history and science classes would then enter the block schedule interdisciplinary science/history class. The teacher who had been the students' former instructor for their separate science and history classes would then become their new science/history teacher as well.

The intention of the implementation design is to determine whether any improvement in student performance (behavior and achievement) is attributable to the new curriculum. By keeping the same group of students through both semesters, and by utilizing the same teacher throughout both semesters, variations in student/student and student/teacher dynamics on student performance can be minimized.

Improvement in students' performance would be measured in the areas of attendance, behavior, class grades, and standardized test scores. These indications of student improvement would serve as the measure of the curriculum's effectiveness.

## **SAMPLE AND POPULATION**

The curriculum would be implemented at the ninth grade level, and the target group would be at-risk students. A study group of twenty-five students who had been enrolled in the A.C.E. program in eighth grade would be selected.

## **ASSUMPTIONS AND LIMITATIONS**

### **Assumptions and Limitations of the Literature Review**

The amount of primary research cited in the literature review is limited to five



studies. Despite extensive investigation, the researcher was unable to find additional data/studies relating to the effectiveness of either interdisciplinary teaching or block scheduling. Other studies may exist which would contradict the findings of the studies which were investigated. Consequently, the results of the studies which have already been conducted may not be absolutely conclusive and it may not be possible to generalize the same results to other settings.

An assumption of the literature review is that combining interdisciplinary teaching with block scheduling will have a positive effect on the behavior, class grades, attendance, and achievement test scores. While it appears a logical assumption that the marriage of two effective approaches would result in an effective product, this may not be the case.

### **Assumptions and Limitations of the Evaluation During Implementation Process**

One limitation of the evaluation of the curriculum's effectiveness during the implementation process would be that the sample size is small (twenty-five students). If the outcome of the evaluation is positive, it may not be possible to generalize the results to other settings. Conversely, if the outcome of the evaluation is negative, it would not necessarily be conclusive that the curriculum would be ineffective in other settings.

Another limitation of the curriculum's evaluation during the implementation process is that of the influence of the teacher involved. The results could vary greatly depending on the teacher's attitude during each stage of implementation. If the teacher is very favorable towards the new curriculum, he/she may unwittingly teach more enthusiastically during the second semester than during the first semester. As a result,

students' performance during the second semester could be inflated. The reverse effect could occur as well, thereby inflating the students' first semester performance.

An assumption of the evaluation during the curriculum's implementation process is that an improvement in the students' performance during the second semester is attributable to the new curriculum within a block schedule. Although the design for the curriculum's implementation process is intended to minimize the influence of outside factors (other than the curriculum) on student performance, it is impossible to completely cancel all other variables.

## PROCEDURE

The procedure for collecting data pertaining to the curriculum's effectiveness during the implementation process would have three parts. The first procedure would be to collect data pertaining to student behavior. The second and third procedures would be to collect data pertaining to student achievement.

First, statistics on behavior referrals, absences, and suspensions would be tracked throughout the year to assess student behavior. Second, student grades would be tracked during the first and second semester to assess student grade changes. Finally, a standardized achievement test, the Metropolitan Achievement Test (MAT), would be administered three times during the year; once at the beginning of the year, once at the end of the first semester, and once at the end of the year to assess academic achievement.



## INSTRUMENTATION

The instruments utilized to measure student behavior would be discipline referral forms and statistics on the number of suspensions (in school and out of school). The instrument utilized to measure student attendance would be statistics on student absences. The instruments utilized to measure student academic achievement would be report cards and the Metropolitan Achievement Test (MAT).

## METHOD OF ANALYSIS

The data collected during the implementation would be analyzed by comparing the statistics from the first semester to the statistics from the second semester. Behavior statistics during the first semester (before the implementation of the new curriculum) and the second semester (after the implementation of the new curriculum) would be compared. Student grades during the first semester (in history and science classes) would be compared to grades during the second semester. The gains in achievement scores during the first semester (the difference between the scores on the first administration of the test and second) would be compared to the gains in achievement scores during the second semester (the difference between the scores on second and third administration of the test).

If student behavior and achievement improve more during the second semester than they did during the first semester, it could be concluded that the implementation of the new curriculum and schedule was responsible for the improvement.

## CHAPTER 4

### PRESENTATION OF THE CURRICULUM

#### OVERVIEW

The proposed curriculum is a science/history course where the interrelation between scientific discovery and the rise of civilization is studied. The methods of instruction utilized in the course would be the same as in a traditional curriculum, including a mixture of lecture, cooperative learning, hands-on activities, labs, student projects, and group presentations. Evaluation of student's performance would be accomplished by a variety of measures such as tests and quizzes, portfolio assessment, essays, research papers, and grades on labs and projects. The intention of the course is that the content will have a heavy emphasis placed on exploring the causal relationships throughout human history between scientific advances and changes in societies. The effects of scientific breakthroughs on civilization will be studied. The effect of societal conditions, attitudes and values on the timing and pace of scientific discoveries will also be studied.

#### COURSE CONTENT AND TEXTS

Since there is no suitable textbook in existence (to the researcher's knowledge), the content of the course would draw upon several scholarly works. The principle text for the timeline and ideology of the course would be Crowther's The Social Relations of Science.

Additional resources would focus on more specific periods of history. These works include Clagett's Greek Science in Antiquity, Grant's Physical Science in the Middle Ages, and Butterfield's The Origins of Modern Science. Lastly, Downs' Landmarks in Science: Hippocrates to Carson would be used as a further resource to study specific scientists and their contributions to society.

Other supporting material from various sources such as public and school libraries would be utilized. History books, artwork, science textbooks, encyclopedias, and computer databases, would be drawn upon by the instructor in rounding out the content of the course.

The use of these texts and additional materials serves to make the course content both accurate and interesting. It is hoped that the more interesting and exciting the instructor is able to make the course, the more likely the course will appeal to at-risk students.

## COURSE OUTLINE

The following outline is an optimistic course structure, with approximated lengths of study for each unit. Since teaching the course would be without precedent, units may require more or less time than allotted, and adjustments would undoubtedly be necessary during the year. One of the units, Pre-Historic Man and Early Discoveries, is described in Appendix A.

## I. Pre-Historic Man and Early Discoveries (3 weeks)

- A. Tools
- B. Fire
- C. Improved Hunting
- D. Agriculture/Irrigation
- E. Power/Animal Domestication
- F. Metallurgy

## II. Ancient Civilizations (4 weeks)

- A. Greece
- B. Babylon/Persia
- C. Egypt/Alexandria
- D. Celts
- E. Aztecs/Incas/Mayans

## III. Roman Empire (2 weeks)

- A. Repute of Manual Work
- B. Social Conceptions of Science
- C. Effects of Slavery
- D. Effects of Economic System
- E. Effects on Medical Research
- F. Architecture and Population Density
- G. Public Spectacles
- H. Transportation Improvements

End of first quarter

IV. Islam (2 weeks)

- A. Early Technical Advances
- B. Resumption and Improvement on Greek and Babylonian Science
- C. Further Successes and Failures
- E. Muslim Alchemy
- D. Science and Muslim Society

V. Early Western Civilization (1 week)

- A. Constantinople
- B. New Social System and its Effects
- C. New Repute of Manual Labor

VI. Middle Ages (3 weeks)

- A. Pursuit of Gain and Mechanical/Technical Development
- B. Roman Catholicism and Science
- C. The Inquisition
- D. Roger Bacon
- E. Clocks and Mills
- F. Technical Advances in Warfare
- G. Rise of Universities

VII. The Renaissance (3 weeks)

- A. Development of Money and Decline of Feudalism
- B. Technical Advances in Warfare



- C. Leonardo DaVinci
- D. Metallurgy and Mining
- E. Effects of Commerce and Gold Discoveries
- F. Galileo
- G. Science and Freedom
- H. Philosophical Climate

End of first semester

#### VIII. Colonial Period (3 weeks)

- A. Robert Boyle and the Royal Society
- B. Shipping and Slavery
- C. Descartes
- D. Lavoisier and Kelvin
- E. The Enlightenment

#### IX. Industrial Revolution (3 weeks)

- A. Climate for Discovery
- B. Raw Materials and Competition
- C. Electricity and Magnetism
- D. Industrial Research Laboratories
- E. Research in Universities
- F. Advances in Warfare
- G. Exploitation of the Masses
- H. Poor Standard of Life

**X. Pre-Nuclear Modern Period (3 weeks)**

- A. Motives and Financing of Continued Research
- B. American Foresight
- C. Science and Imperialism
- D. Social Reform and Improved Standard of Life
- E. Improved Medicine and Health
- F. Rapid Pace of Research in Physical Sciences
- G. Stable Families/Social Structure
- H. Economic Instability
- I. Growth of Government

End of third quarter

**XI. Post-Nuclear Modern Period (6 weeks)**

- A. Arms Race and Fear
- B. Space Race and Public Dividends
- C. Rapid Pace of Research in Natural Sciences
- D. Improved Agriculture and Surplus
- E. Rapid Pace of Technological Advances in Medicine
- F. Genetic Research
- G. Depletion of Natural Resources/Emergence of Recycling
- H. Global Population Explosion
- I. Global Communication Explosion
- J. Transportation Improvements

K. Rapid Growth of and Access to Information

L. Terrorism

M. Exploration of Earth

N. Exploration of Space

O. Peace Dividend

P. Civil/Human Rights Improved

Q. Rapid Development of Computer Technology

R. Increase in Crime and Drug Abuse

S. Breakdown of Family Unit

T. Pollution and Toxic Waste

U. Human Rights Violations

V. New Diseases Emerging

W. Ethnic and Civil Wars

## XII. Future (3 weeks)

A. Further Exploration of Earth

B. Further Exploration/Colonization of Space

C. Further Genetic Engineering

D. Increased Lifespans

E. Increased Standard of Living

F. Urgency for Conservation

G. Alternate Energy Sources

H. Global Emphasis on Human Rights



- I. Artificial Intelligence
- J. Increased Leisure Time
- K. War on Crime
- L. Increased Peace and Prosperity
- M. Cashless Societies
- N. Consolidation of Governments/Nations
- O. Privacy Issues
- P. Changes in Family/Social Structures
- Q. Eradication of Diseases-Genetic or Otherwise

End of second semester

This outline is an experimental schedule and would probably evolve each year as the teacher modified and made improvements to the course.

Since the course deals equally with science and history, administrators could potentially offer it as a fulfillment of one credit in each subject for a total of two credits (if enrolled for an entire year). If the student is enrolled for one semester, the student might be awarded one credit in either subject or one half a credit in history and one half a credit in science.

## SAMPLE UNIT

The three week unit on Pre-Historic Man and Early Discoveries will serve as an example of the course content, and is located in Appendix A. This sample unit contains all lesson plans, student objectives, activities, and student assessments which would be

utilized. Activities, lesson plans, and assessments would likely change each year, as teachers observe which lessons work well and accentuate/facilitate student learning. Some lessons may require modification, while others may be eliminated altogether. Still others may be added as instructors see fit.

## ADMINISTRATIVE CONSIDERATIONS

Some of the activities planned for this unit may be inappropriate due to safety concerns. Administrators may not approve of making and using hunting tools for fear that students may accidentally (or intentionally) injure themselves or others. In such a case, the activities could be modified to teacher demonstrations. Demonstrations can facilitate the same higher order thinking skills through analysis questions (after the demonstration) without the potential danger to students.

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## SUMMARY

The purpose of this study was to develop an interdisciplinary curriculum to be taught in a block schedule for at-risk students. The following research question was asked: would such a curriculum be effective? Literature was reviewed in an attempt to answer the question. The literature investigated pertained to the effectiveness of block scheduling and interdisciplinary teaching, independent of each other. It was found that each approach was effective for at-risk students, independent of each other. Based on the findings of the literature review, the assumption was made that combining block scheduling and interdisciplinary teaching would result in an effective product.

To further answer the research question, a method was developed for evaluating the effectiveness of the curriculum once implemented. The method entailed tracking the performance of a group of at-risk students who had the same teacher for a semester of traditional curriculum in a traditional schedule and a semester of the proposed curriculum in a block schedule. The students' behavioral and academic performance during the semesters would then be compared, and any improvement could then be attributed to the new curriculum.

The proposed curriculum, entitled Science and Civilization, was then presented. The materials and texts which were utilized to create the course were described, and a

course outline was provided. A sample unit, including all lesson plans, student objectives, activities, and assessments was given as an example of the course content.

The proposed curriculum is just one example of the possibilities that could be created. Other interdisciplinary combinations such as a math/science course, or an English/history course could also be utilized within a block schedule.

## CONCLUSIONS

The research question was answered, in part, by the pre-evaluation of the curriculum. However, although there is some evidence that block scheduling and interdisciplinary teaching are effective independent of one another at helping at-risk students, no research was found regarding the effectiveness of combining the two approaches. It may be that the proposed curriculum with its intent to help at-risk students is without precedent. If this is so, then the implementation and subsequent evaluation of the curriculum could prove to be very valuable to the educational community. It is hoped that the limited evidence which is available will be favorable enough for a school district (and a particular school administration) to seriously consider an experimental implementation of the proposed curriculum. After the curriculum is implemented, its true effectiveness could be measured, and the research question could be fully answered.

## RECOMMENDATIONS

Finally, it is recommended that a highly enthusiastic, experienced teacher be chosen for the implementation of this curriculum. It is also highly recommended that this



teacher be a person who enjoys children, and who is experienced in dealing with at-risk students. If the teacher who is selected for the implementation does not possess these qualities, it is possible that the potential benefit from the curriculum would be undermined (the students may perform poorly with a poor teacher).

As the students might perform better under such an excellent teacher, there could be concern that the results of the implementation would be skewed, but this potential concern would be unfounded. The research design compensates for any increase in student performance due high quality teaching. Since students would be taught by the same teacher during both semesters, any increase in performance due to the quality of teaching would occur during both semesters. Consequently, only the difference between the students' performance before and after the implementation of the new curriculum would be significant for the purposes of this study.

Implications for future research and further recommendations regarding the curriculum's effectiveness are pending the curriculum's implementation and subsequent evaluation.

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APPENDIX A

SAMPLE UNIT



## Lesson Plans

### Explanation:

The lesson plan for each day takes advantage of the double length period under the block schedule by engaging students in a wider variety of activities than is possible during a traditional length period. An approximate time for each activity is given, as well as the number of each objective which is addressed by the activity. A list of numbered student objectives is found beginning on page forty-five. The amount of time allotted for each activity is intended to provide sufficient time to complete the activity satisfactorily without being too long and potentially boring students.

Student activities will be conducted during class, but answer accompanying analysis questions may require homework. Student writing assignments will be assigned and explained in class, with some time provided for writing during class. However, as students will likely not complete these assignments during class, finishing the assignments at home will be required. The time allotted during class for these assignments is mainly to give the students an opportunity to ask questions and receive clarification from the teacher concerning the assignments. All student writing assignments will be placed in the students' portfolios.

Cooperative group work will be for the purpose of brainstorming to answer analysis/synthesis type questions which are posed by the teacher. The results of these group efforts will be retained by each group member and added to their individual portfolios.

Student projects are to be done by students at home, as no time is provided for them during class. Completed projects will be added to each student's portfolio.

**Week 1: Tools and Fire (A and B of course outline)**

**Monday**

- 10 min. -Introduction of course (content, grading, teacher expectations, etc.)
- 15 min. -Organizing/assigning and explanation of cooperative learning groups
- 15 min. -Discussion of lifestyle, social structure, and skills of pre-historic man (objective 1)
- 15 min. -Cooperative group work on types, purpose, and origin of tools (objectives 2,3)
- 20 min. -Student activity with identifying and comparing modern and ancient tools (objective 2)
- 15 min. -Student writing activity describing quality of life before and after the invention of tools (objectives 3,4)

**Tuesday**

- 15 min. -Discussion of man's need to develop tools driving their invention (objectives 3,7)
- 15 min. -Cooperative learning work on the ability to construct shelters as a result of tools, and the impact this had on early man's social structure (the beginnings of communities rather than being dispersed among available natural shelters) (objective 4)

- 50 min -Student activity with making ancient tools (objectives 3,7)
- 10 min. -Assign student project (choice to build a model of an early dwelling constructed with primitive tools or make a drawing of some aspect of daily life during this time such as foraging for food) (objective 4)
- Wednesday
- 15 min. -Cooperative group work on quality of life before and after the discovery of how to make and control fire (objective 5)
- 50 min. -Student activity making fire tools and fire(objectives 5,7,8)
- 15 min. -Student writing assignment on the other benefits/impact associated with the discovery of fire (such as primitive experience with chemical reactions within food and fuel during cooking, food preservation, and greater understanding of combustion, ability to inhabit harsher climates and work into the night, as well as socialization around the fire) (objectives 5,7)
- 10 min. -Discussion of the scientific principles involved with the production of fire (combustion, conservation of matter, exothermic chemical reactions, chemical vs. physical changes etc.) (objectives 5,8)
- Thursday
- 15 min. -Cooperative group work on the impact of the invention of pottery (such as the ability to store larger amounts of water than in wood and animal hide containers, and the implications for surviving drought and the ability to roam further from water sources) (objectives 6,7)
- 15 min. -Discussion of additional knowledge gained by perfecting pottery (such as

improved control of fire, ability to achieve higher temperatures with control, and greater understanding of chemical reactions within clay and glaze when fired) (objectives 6,7,8)

60 min. -Begin student field trip within school to pottery room to make and fire pottery (objectives 7,8)

Friday

90 min. - Complete student field trip within school to pottery room to make and fire pottery (objectives 7,8)

Week 2: Improved Hunting, Agriculture and Irrigation (C and D of course outline)

Monday

All period -Field trip to Desert Botanical Garden to visit section on the Peoples of the Sonoran Desert (examples of early hunter/gatherers) (objectives 9,10,12)

Tuesday

15 min -Discussion of experiences during Monday's field trip (objectives 9,10,12)

20 min. -Student writing assignment on ranking the levels of civilization exhibited by the early societies studied during field trip (objectives 9,10,12)

25 min. -Cooperative group work on the limitations and successes of hunting with early tools, beginning with none, then stones, slings, spears, spear throwers, bow and arrow, fishing nets, and finally blowguns with poison (objective 9)

25 min. -Discussion of the physics of various hunting tools (acceleration, velocity,



kinetic and potential energy, force, pressure, levers, projectile motion etc.)

(objective 11)

-Student writing assignment on the accumulation/advancement of technical knowledge, creativity, and experimental/problem solving skills associated with the development of improved hunting tools over time)

(objectives 10, 12)

### Wednesday

90 min. -Student activity with making and using improved hunting tools

(objectives 9,11)

### Thursday

15 min. -Discussion of difficulties/successes with Wednesday's activity

(objectives 9,11)

20 min. -Student writing assignment from the perspective of an early hunter

(objective 10)

15 min. -Discussion of the trend towards increased cooperation between hunters in order to achieve greater success and to kill bigger game (objective 12)

20 min. -Cooperative work on the impact on the family/social structure as a result of hunting in larger groups for larger game (objectives 12,13)

20 min. -Student writing assignment on the additional uses of large game animals' body parts for an improved standard of living (eg. hides, internal organs, bones, sinew etc.) and the gain of zoological, anatomical, and botanical knowledge as a result of observing and utilizing game animals (obj. 12,13)

Friday

- 20 min. -Discussion of how the danger/risk of hunting large game (which became a necessity due to needs of a larger community structure) along with availability of large numbers of big game and/or difficulties in following migrating herds, encouraged people to develop agriculture (objective 13)
- 25 min. -Cooperative work on the social ramifications of progress in agriculture from only gathering to the intentional planting and selective breeding of crops (ex. wheat from grass), and from dependence on seasonal rains, to the invention of irrigation (objective 14)
- 20 min. -Student writing assignment on how improved agriculture led to greater social stability, the advent of leisure/recreation time, and the beginning of trade, specialization and bartering (primitive economies), as well as other benefits such as new/improved materials for clothing (objective 14)
- 25 min. -Discussion of the scientific principles which were learned as a result of experimenting with agriculture (photosynthesis, efficiency of eating plants rather than animals, germination, pollination, hybridization, erosion, plant anatomy etc.) (objective 15)

Week 3: Power, Animal Domestication, and Metallurgy (E and F of course outline)

Monday

All day -Field trip to Hohokam Indian ruins and irrigation canals (objective 16)

## Tuesday

- 15 min. -Student writing assignment on the rise of early agricultural civilizations near water sources (objective 16)
- 10 min. -Assign student project (choice between building a model of a tool incorporating a wheel and axle or lever, or making a drawing of some aspect of daily life such as farming or hunting in large groups) (objective 17)
- 15 min. -Discussion of how irrigation improved crop yields to the extent that harvests could no longer be processed effectively with primitive methods such as a mortar and pestle and new means of grinding grain had to be developed, such as the rolling stone and ultimately the stone wheel (objectives 16,17)
- 35 min. -Student activity with a contest between grinding speeds of mortar and pestle and stone wheel (objectives 17,18)
- 15 min. -Student writing assignment on the development of the wheel in other areas of life, such as transportation of surplus goods, and how it facilitated trade between peoples (objective 17)

## Wednesday

- 20 min. -Discussion of the physics of the wheel and axle and other simple machines, such as the inclined plane and lever, which were being developed for the purpose of building structures (often religious in nature), getting water, etc. needed for ever growing populations (obj. 18)

- 40 min. -Student lab with wheels, levers, and inclined planes (objective 17,18)
- 15 min. -Cooperative work on the growing need for a source of power other than human power in the areas of agriculture and transportation led to the domestication of animals to draw plows, pull carts, and turn large grinding wheels (objective 19)
- 15 min. -Student writing assignment on the impact of beasts of burden on emerging civilizations (even more leisure, acceleration in specialization of trades, and improved trade/communication between societies)(obj.20)
- Thursday
- 15 min. -Discussion of how growing populations drove the need to improve agriculture with wood and stone tools and led to the discovery and development of metallurgical skills (effectiveness and durability of metal tools vs. wood or stone tools) (objective 21)
- 30 min. -Student activity with comparing/testing the hardness of various metals (objective 23)
- 15 min. -Cooperative work on the relative difficulty in mining, refining, and fashioning metal tools of various metals/alloys, and how the chronological sequence of each metals' usage was dependent on current technology (eg. control of fire for refining, pottery skills for crucibles etc.) (objective 24)
- 15 min. -Discussion of the scientific principles involved in metallurgy (heat, temperature, melting point, mixtures, alloys, nature of metallic bonds) (objective 22)



- 15 min. -Student writing assignment on the additional benefits/impact of metallurgy to emerging civilizations, such as metal tips for weapons, discovery and refinement of precious metals for use in religious practice/rituals, the further development of specialization and social strata (classes) (objective 25)

Friday

- 10 min. -Collect student portfolios for unit 1 (containing all writing assignments, drawings/projects, cooperative group work and class notes)
- 30 min. -Review of entire unit (objectives 1-25)
- 50 min. -Test on unit one (objectives 1-25)

### Student Objectives

Explanation:

The objectives for this unit reflect the larger objective (goal) of the course; namely, to study the interrelation between scientific discovery and the rise of civilization. Each objective relates to the goal of the curriculum by directing students to make meaningful connections between history and science.

The student objectives for this unit are listed by week and numbered. Students should have demonstrated mastery of the objectives for each week by week's end. Mastery of the weekly objectives will be measured by student writing samples, student projects, and student activities. A unit test will measure the level of student mastery of the objectives for the entire unit.

The various activities outlined in the daily lesson plans are linked to the weekly objectives. The objectives addressed by each activity are referred to by number in the lesson plans.

- Week 1:
1. Describe the lifestyle, social structure, and skills of pre-historic man
  2. Identify early tools and their function
  3. Discuss the causation between the need for improved tools and their invention
  4. Describe the social implications which occurred as a result of improved tools (such as the ability to construct shelters enabling man to dwell in communities rather than being dispersed among available natural shelter)
  5. Explain how fire was produced, and describe the beneficial effects it had on the life of early man
  6. Discuss the impact that the discovery of pottery had on pre-historic man's quality of life
  7. Describe the developing curiosity, inventiveness, and resourcefulness which occurred as early man experimented with tools, fire, and pottery, and discuss the significance of these traits as they relate to early scientific thought and progress
  8. Explain the scientific principles involved in fire and its production, and in the production of pottery (eg. combustion, friction, chemical vs.

physical changes, conservation of energy, chemical reactions, and chemical bonds)

Week 2:

9. Describe the improvements in hunting tools
10. Discuss the impact improved hunting tools and techniques (eg. cooperation) had on man's family/social structure
11. Explain the scientific principles involved in the functioning of various hunting tools (kinetic and potential energy, acceleration, velocity, force, pressure, momentum, friction, projectile motion, Bernoulli effect, drag etc.)
12. Describe the effect of improved hunting on man's quality of life, and the resulting accumulation of early anatomical, zoological, and botanical knowledge
13. Relate the increased risk involved in hunting larger game to the pursuit and development of agriculture
14. Discuss the impact of improved agriculture (selective breeding and irrigation) on social stability, and relate its advent to the beginnings of specialization, trade, and leisure/recreation time, and describe other associated benefits such as new/improved materials for clothing
15. Explain the scientific principles involved in agriculture, such as hybridization, pollination, germination, photosynthesis, the energy efficiency of eating plants rather than animals, erosion, plant anatomy

## Week 3: The Wheel and the Lever

Week 3:

16. Discuss the impact of irrigation on crop yields and how the resulting need to develop improved methods for processing harvests led to the invention of the grinding wheel
17. Describe other uses of the wheel which were developed (eg. uses in transportation), as well as the uses of other simple machines (inclined plane and lever) for the purposes of building structures, getting water etc. needed for ever growing populations
18. Explain the scientific principles involved with the use of simple machines (work, input force, output force, mechanical advantage, torque, and efficiency)
19. Discuss how the need for power (other than human power) in the areas of agriculture and transportation led to the domestication of animals (to draw plows, pull carts, and turn large grinding wheels)
20. Describe the impact of beasts of burden on emerging civilizations
21. Discuss how growing populations drove the need to further improve tools for agriculture, and how this need contributed to the discovery and development of metallurgy
22. Explain the scientific principles involved in metallurgy (heat, temperature, melting point, boiling point, mixtures, alloys, and the nature of metallic bonds)
23. Rank various metals and alloys according to hardness, and arrange



them in order of chronological discovery/use

24. Describe how man's success with metallurgy was dependent on previous technological progress (eg. control of fire for refining and pottery skill for crucibles)

25. Describe the additional benefits/impact metallurgy had on emerging civilizations

## Science and Civilization Activity #1

Name \_\_\_\_\_

## Identifying and Comparing Modern and Ancient Tools

Date \_\_\_\_\_ Per \_\_\_\_\_

*Procedure:* Fill in the table below with your observations of the tools which are circulating around the room.

Tool Age and Number	Description of Tool	Function or Use of Tool

*Questions:*

1. What kind of material are the ancient tools typically made of? Why?
2. What kind of material are the modern tools made of? Why?
3. What similarities do you see (design and function) between the ancient and modern tools?
4. Which age of tools works better and/or lasts longer? Why?
5. Suggest some ways the ancient tools be improved without modern technology!

## Science and Civilization Activity #2

Name \_\_\_\_\_

## Making Ancient Tools

Date \_\_\_\_\_ Per \_\_\_\_\_

*Materials:*

Flint and/or shale stones of various sizes and shapes

Sticks/branches of various lengths and thicknesses

Blunt stones of various sizes

Fibrous plant leaves (such as Yucca) before and after partially decomposing

*Procedure* (part A): Early Tools

1. Use a stone to break chips off of a piece of shale or flint, until a sharp edge is produced on one side.
2. Use the flint/shale knife you've just made to sharpen the end of both a small stick and a larger branch.

*Questions:*

1. What other uses can you think of for a shale/flint knife?
2. What kind of uses are there for the small and large sharpened stick?
3. What other kind of tool could be made with the addition of plant fibers?

*Procedure* (part B): Improved tools

1. Attempt to pound the plant fibers loose from the new leaf with a blunt stone.
2. Attempt pounding the plant fibers loose again, but this time use the partially

decomposed leaf.

3. Put the loose fibers together in a bundle and tie one end of the bundle to a stick.

Weave the plant fibers together as you pull the stick against your knees. Tie a knot in both ends of the rope you've made when finished.

4. Use your flint/shale knife to make a split in the end of a large branch by "hammering" it as a wedge with a blunt rock, place a blunt stone between the split halves, and tie the stone tightly into the end of the branch with the rope.

5. Repeat the steps 2-4, but use a smaller stick and fasten your flint/shale knife in the end rather than a blunt stone. Before fastening your knife into the stick, sharpen the other side and create a point at one end of it while leaving the other side blunt.

*Questions:*

1. What tasks could be performed with the first improved tool?

2. What advantage does this tool have over just using a rock with one's bare hand?

3. What tasks could be performed with the second improved tool?

4. What tasks could be performed with the second tool if the knife head were round or square? What if it were rotated?

5. List all the simpler tools which were used in the manufacture of the improved tools.

6. What were the disadvantages and limitations of the simple tools, and how were these problems partly solved by the new tools?

7. What disadvantages and limitations do the improved tools still have? How could these tools be improved even more?



Science and Civilization Activity #3

Name \_\_\_\_\_

Making Fire Tools and Fire

Date \_\_\_\_\_ Per \_\_\_\_\_

*Materials:*

Flint/shale knife (assumed to have been made already)

Pieces of bark

Dry and "green" sticks/branches

Fibrous plant rope (assumed to have been made already)

Blunt stones with indentions

Tinder (small dry bits of leaves, bark etc.)

*Procedure* (step A): Hand Drill Technique

1. Sharpen a dry, stiff stick at one end with your knife.
2. Carve an indention into the center of a piece of bark with your knife (this will serve to hold the tip of your sharpened stick in place during spinning). Also carve a "v" shaped notch into the side of the bark, with the point of the "v" touching the indention in the center and widening out towards the edge of the bark.
3. Place some tinder in the notch, and place the sharpened end of the stick into the indention.
4. Put one foot on the piece of bark (to keep it from moving), position the shaft of the stick between your open palms (as if you were clapping your hands and the stick got stuck between them), and rub your hands back and forth furiously!

*Questions:*

1. Were you able to produce a spark in the kindling from the friction produced between the point of the stick and the indentation?
2. Do you think many people were able to produce fire in this way? Why?

*Procedure (part B): Bow Technique*

1. Tie one end of your rope to the end of a "green" (flexible) branch. Wrap the rope around the shaft of your sharpened stick several times, and then tie the loose end of the rope to the other end of the branch while flexing it in a curved shape. The branch should now look like a bow, only with a stick stuck in the string!
2. Put some tinder in the notch of the bark, put your foot on the piece of bark, and place the point of your stick into the indentation.
3. Grasp a blunt stone (carefully chosen because it has an indentation on the bottom) with one hand (non-primary), and with the other hand put the top of your stick (opposite the sharpened end) into the indentation on the bottom of the stone.
4. Grasp the center of the bow with your primary hand, and "saw" back and forth with it!

*Questions:*

1. Were you able to produce a spark in the tinder?
2. Which was more tiring, the hand drill or the bow technique?
3. Which technique caused the stick to spin faster? Why?

4. What effect does the rate of spin have on the amount of friction produced? Relate this to the chances of success with both techniques.
5. Get the chemical equation for combustion from your instructor. Write the complete equation below.
6. You will notice that on the right side of the arrow, energy is produced. What forms are this energy in during combustion? Name at least three uses for this energy!
7. Look again at the chemical equation for combustion. You will notice that carbon is also produced during combustion. What evidence is there of this?
8. What other evidence is there of a chemical change occurring?
9. Do you think that it seemed to pre-historic man as if matter were being destroyed by fire? Why?
10. What is the name of the law which states that matter cannot be destroyed? Are there any exceptions to this law?

Science and Civilization Activity #4

Name \_\_\_\_\_

Making and Using Improved Hunting Tools

Date \_\_\_\_\_ Per \_\_\_\_\_

*Materials:*

Small smooth stones

Large and small pieces of flint/shale

Straight, dry sticks and branches (assumed to be already collected/cut)

Strong, flexible "green" branches

Plant fiber rope (assumed to have been made already)

Pieces of leather (assumed to have been made already from animal hides)

Reeds (with safety mesh over one end) and long thorns

Archery targets

*Procedure A: Stones and Slings*

1. Choose a stone about the size of a baseball. This is your first hunting tool. Throw it at the target with as much force and accuracy as you can!
2. Select a smaller size stone for use in a sling. Fashion the sling by piercing a piece of leather with four holes (two on each edge, opposite from each other), and tying two separate fiber ropes to each side.
3. By tying each rope to two holes simultaneously, a cradle is formed for your rock to fit in. Tie a loop in one of the ropes big enough for your hand to fit through it. This will be the end that is grasped and not released during use.



4. Put your hand through the loop (over fingers and around palm), grasp the free end with the same hand, and place the stone in its cradle. The stone should be hanging in its cradle without falling out. With a smooth swing, twirl the sling upwards, making circles over your head. Release the loose end of the string when you want the stone to fly out, and try to hit the target!

*Questions:*

1. What advantage is throwing stones over chasing prey and catching them by hand or striking them with a club? (Hint: would you rather run to first base and tag the runner out, or throw the ball to the first baseman?)
2. What advantage is there to using a sling vs. throwing stones by hand?
3. What disadvantages are there to using a sling?
4. What kind of animals could be killed with these tools?

*Procedure B: Spear and Spear Thrower*

1. Make a flint/shale spear point (double sided knife with a point)
2. Select a long, thick branch and make a split at one end.
3. Insert the spear point and lash it tight to the end of the spear.
4. Throw the spear at the target as forcefully and accurately as possible!
5. Repeat steps 1-3 again, only make a smaller version of the spear.
6. Select another stick of equal length that is thicker on one end (and preferably slightly curved on the thicker end).
7. Carve out a scoop shaped notch at the thick end of the stick, such that the blunt end of

the smaller spear will catch in it. This is your spear thrower.

8. Place the spear in the thrower and grasp the end of the thrower opposite the notch.
9. With the same hand, use your index finger and thumb to steady the spear (you will be steadying the end with the point).
10. In one motion, fling the thrower forward towards the target with an overhand motion while releasing the spear but not the thrower!

### *Questions:*

1. In what ways is a spear a better hunting tool than a club, stone, or sling?
2. How could a spear be used other than being thrown?
3. What could be done to improve the "grip" on the spear so as to apply more force?
4. What advantages does the spear thrower have as compared to a regular spear? Why?
5. What disadvantages does the spear thrower have?
6. What kind of animals could be killed with these tools?

### *Procedure C: Bow and Arrow*

1. Make a miniature "spear" with a smaller stick and flint/shale. Be sure to choose a long shaft for your arrow, and carve a "v" shaped notch in the end opposite the point.
2. Make a bow with a "green" branch and fiber rope similar to the one constructed for making fire, only make this bow approximately twice as big.
3. Grasp the bow at its mid point with your non-primary hand, and use your primary hand to "knock" your arrow on the string. This is accomplished by tilting the bow sideways and resting the arrow shaft near the point on the bow, while inserting the string in the notch

opposite the point. You may wish to extend your index finger on the hand holding the bow so as to steady the arrow when the bow is raised and fired.

4. Grasp the string and notched end simultaneously with the first two fingers and thumb of your primary hand.
5. Raise the bow to vertical, pull the arrow back to your cheek, sight down the shaft at the target, and let it fly!

*Questions:*

1. What advantages does the bow and arrow have over other hunting tools? Why?
2. What could be done to improve the accuracy of the arrows? (other than practice!)
3. What disadvantages are there with the bow and arrow as compared to a spear?

*Procedure D: Blowgun*

1. Select a long reed and place a safety screen over one end and secure it with a rubber band (this is to guard against inhaling the dart!).
2. Choose a long thorn whose base is slightly bigger in diameter than the inside of your reed, and "whittle" the thorn until it fits inside the reed without getting stuck.
3. Let the thorn dart slide down the inside the reed with the point facing the open end.

Your blowgun is now loaded! Aim the blowgun at the target and blow!

*Questions:*

1. What advantages does the blowgun have compared to other hunting tools? What disadvantages?
2. Since poison darts are required for lethality, what dangers are there in using it?

## Science and Civilization Activity #5

Name \_\_\_\_\_

## Comparing and Testing the Hardness

Date \_\_\_\_\_ Per \_\_\_\_\_

## of Various Metals

*Materials:*

Copper and copper ore      Tin and tin ore      Bronze

Iron and iron ore      Carbon      Steel

*Procedure:* Fill in the table below with your observations of each substance (not including the ores) as they are circulating around the room.

Name of Substance	Appearance	Rank in Hardness

*Questions:*

1. Which two substances are alloyed together to make bronze?
2. Which two substances are alloyed together to make steel?
3. Which metal would make the most durable tools? (resist breaking, keep their shape and edge longer)
4. List the order in which the metals were discovered/refined. Which one is "modern"?





*Questions:*

1. Which tool is faster at processing grain?
2. Which tool is more tiring?
3. What principle do both tools utilize?
4. Why does the grinding wheel use this principle more efficiently? (Hint: how much grain is contacted at any one moment?)
5. In the mortar and pestle, what generates the force to create the friction needed?
6. With the grinding wheel, what generates the force needed to create the friction? Relate this to its ease of use!
7. Explain why the mortar and pestle could never be made into a giant tool, whereas the grinding wheel could (and was!)
8. When turning the grinding wheel, is it easier to turn the wheel by pushing toward the inside or the outside of the wheel? Why?

Science and Civilization Activity #7

Name \_\_\_\_\_

Simple Machines Lab

Date \_\_\_\_\_ Per \_\_\_\_\_

*Materials:*

Spring scales (to measure force)    Meter sticks    Ramps    String

Small and large rocks    Large sticks    Carts with large and small wheels

## Procedure A: Levers

1. Tie a piece of string around a small rock (this is your load, or what you want to move), hook a spring scale to the string, then lift the rock straight up with the scale and measure the force required.
2. Remove the scale from the rock and tie the rock to the end of a stick (this will be your lever). Use a meter stick to determine the mid-point of the lever, and place an even larger rock under the middle of the lever. (this will serve as your fulcrum)
3. Hook the spring scale on the lever, opposite the rock, and pull down. (the lever should be pivoting on the larger rock at its center).
4. Repeat step 3, but put the fulcrum one fourth of the way in from the end nearest the rock.
5. Record all results below.

	Without Lever	Fulcrum in Middle	Fulc. @ 1/4 Point
Force Required			

### Questions:

1. The side of the lever between the fulcrum and the load is called the resistance arm. The side of the lever where effort is applied is called the effort arm. What relationship do you see between the length of the effort and resistance arms and the amount of force required to lift the same object?
2. How is it possible to lift the same object with less force?! (Hint: look at how far stone moved in each case compared to the distance the effort moved!)
2. What kind of tasks would this simple machine be useful for?
2. What other arrangements for the effort, load, and fulcrum can you think of?
3. How would these different arrangements function? What tasks would they be useful for?

### Procedure B: Inclined Plane

1. Select a large stone and tie a string around it. Pull the stone up the ramp and measure the force required to pull it.
2. Measure both the height and length of the ramp.
3. Lift the same stone straight up to the same height as the ramp, and measure the amount of force required to lift it.



4. Record data in the table below.

	Force Required to Lift or Pull	Distance or Height Moved
Without Ramp		
With Ramp		

*Questions:*

1. Why did pulling the stone up the ramp require less force than lifting it straight up?

(Hint: compare the distance the load was moved in each case!)

2. Is the inclined plane as efficient as the lever? Why is this? (Hint: how much contact is there between the load and the ground in each case?)

**Procedure C: Wheel and Axle**

1. Place a stone on a cart and pull it with a spring scale. Measure the force required.

2. Remove the stone and pull the empty cart. Measure the force required.

3. Tie a string around the stone, pull the stone across the ground without the cart and measure the force required.

4. Subtract the force required to pull the empty cart from the force needed to pull the cart and the stone together. (this is the force required to pull the stone when using a cart!)

4. Record data in table below.

	Cart & Stone (A)	Empty Cart (B)	Stone Alone (C)	Stone When Pulled With Cart (A - B)
Force Required				

*Questions:*

1. Which force is greater, the force required to pull the stone alone, or the force to pull the stone when using a cart? Why is this so? (Hint: How much of what's being pulled is in contact with the ground?)
2. How could grease be used to reduce the force even more?

*Procedure D: Wheel and Axle Continued*

1. Select a cart with large wheels and a cart with small wheels. Measure the circumference of both wheel sizes.
2. Choose a starting point on the floor and roll each cart one wheel revolution. Measure the distance each wheel travelled.

*Questions:*

1. What advantage is there to having larger wheels?
2. If the axle were made thicker (perhaps to make it resistant to breaking), what effect would it have if the wheel remained the same size?

Science and Civilization

Name \_\_\_\_\_

Unit 1 Test

Date \_\_\_\_\_ Per \_\_\_\_\_

I. Matching: Match the best definition on the left with the terms on the right.

- |  |                         |
|--|-------------------------|
| ___ 1. A ramp, stairs, or escalator            | A. Work                 |
| ___ 2. Force times distance                    | B. Machine              |
| ___ 3. A circular lever                        | C. Wheel                |
| ___ 4. Makes work easier by multiplying effort | D. Inclined Plane       |
| ___ 5. Output force divided by input force     | E. Lever                |
| ___ 6. Force divided by area                   | F. Tool                 |
| ___ 7. Helps in performing a task              | G. Mechanical Advantage |
| ___ 8. A push or pull                          | H. Drag                 |
| ___ 9. Air resistance during flight            | I. Force                |
| ___ 10. A prybar, flyswatter, or scissors      | J. Pressure             |

II. True/False: Write T or F in the blank for the following statements.

- \_\_\_ 11. Wood and stone are more durable than metal.
- \_\_\_ 12. The discovery of how to make and control fire had little impact on man's existence.
- \_\_\_ 13. The scientific principle first used to generate fire was friction.
- \_\_\_ 14. All metals were discovered at roughly the same time.
- \_\_\_ 15. Fire is an endothermic reaction.

- \_\_\_ 16. As hunting tools improved, and man learned to cooperate, larger game could be killed, and larger social groups could be maintained.
- \_\_\_ 17. Man's success with metallurgy was unrelated to his previous technological progress.
- \_\_\_ 18. The invention of tools enabled man to inhabit a greater number of environments.
- \_\_\_ 19. Irrigation enabled man to settle and prosper in larger numbers and in more places than ever before.
- \_\_\_ 20. Beasts of burden were domesticated for the purpose of entertainment.
- \_\_\_ 21. Advances in metallurgy helped to further define social classes.
- \_\_\_ 22. Agricultural development had a profound impact on man's social structure.

### III. Listing: list the items requested

23. List three types of metal which were discovered/developed by early man. (alloys count as a different metal)

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_

24. List the 3 earliest simple machines discovered/used:

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_

25. List 3 improvements in hunting tools (starting from the simplest):

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_

27. List 3 factors which greatly impacted agriculture:

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_



IV. Matching: Match the best definition on the left with the term on the right.

- |  |                           |
|--|---------------------------|
| ___ 28. Velocity times mass                          | A. Acceleration           |
| ___ 29. Matter neither created nor destroyed         | B. Velocity               |
| ___ 30. Stored energy                                | C. Momentum               |
| ___ 31. Force created by differences in air pressure | D. Alloy                  |
| ___ 32. Solid solution of metals                     | E. Photosynthesis         |
| ___ 33. Energy of motion                             | F. Combustion             |
| ___ 34. Reaction plants use to make food             | G. Conservation of Matter |
| ___ 35. Burning of fuel with oxygen                  | H. Bernoulli effect       |
| ___ 36. Reaction where energy is released            | I. Potential Energy       |
| ___ 37. Change in velocity over time                 | J. Kinetic Energy         |
| ___ 38. Distance travelled over time                 | K. Exothermic Reaction    |

V. Multiple Choice: choose the best answer to the following questions.

- \_\_\_ 39. Which of the following was NOT an effect of the invention of pottery?
- Ability to roam farther from water sources and survive drought
  - Increased knowledge of chemical interactions
  - Made refining of metals possible with crucibles
  - Improved ability to control fire
  - None of these

\_\_\_ 40. Which of the following was an effect of the discovery of fire?

- a. Ability to inhabit harsher climates
- b. Greater understanding of chemical reactions
- c. Ability to cook and preserve food
- d. Ability to work and socialize into the night
- e. All of these

\_\_\_ 41. Identify the statement(s) that describe the impact of agriculture:

- a. Agriculture enabled people to live in larger, more stable social groups
- b. Agriculture created leisure time
- c. Agriculture had little impact on man's quality of life
- d. Agriculture made specialization possible
- e. None of these
- f. a and b
- g. a, b and d

\_\_\_ 42. Which of the following is true concerning the development of metallurgy?

- a. It improved the quality of tools and weapons
- b. It was a common skill
- c. It facilitated the development of religions
- d. It continued the trend toward specialization
- e. all of these
- f. a, c and d
- g. a and d

VI. Essay: Give a thorough answer to the following question. Remember to use complete sentences and correct grammar!

43. Describe how animal domestication impacted each area of man's life, and relate these effects to the emergence of early civilizations.

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