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The Backpack Unit: an S-STS Curriculum

in cooperation with
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Worcester, MA

and

Worcester East Middle School
Worcester, MA

An Interactive Qualifying Project

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Abstract

The purpose of this project was to develop and evaluate a curriculum that integrated health, science, and mathematics to provide an alternative to the traditional method of teaching science. This unit, which centers on the widely publicized concern regarding the heavy backpack weights carried by today's 4^{th} to 8^{th} grade students, was presented to a health class at North High School. Previous W.P.I. project groups using health thematics have had more limited success than those using social and environmental thematics. However, the two prior efforts were themed on skin cancer and Alzheimer's disease. Both of these diseases are degenerative, can be fatal and generally affect adults. The backpack health issue used in this curriculum was different in that these other "dreaded" health issues can lead students to feel overwhelmed and helpless. In contrast, the backpack issue affected the students' lives immediately and they could do something about it to protect themselves. The scope of this project included unit development, field testing, data collection, and analysis periods; its final success was measured by student's performance, teacher evaluations, and our observations.

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Chapter One: Introduction

In today's technologically fast-paced society, teaching about science and technology to younger students has become increasingly important. Students' interest in the natural world peaks around 6^{th} grade, and by 8^{th} grade social concerns are emerging. The idea to use the emerging social concerns to motivate continued study of science inspired a new type of teaching style developed by Rustum Roy and Leonard Waks known as "teaching Science through Science, Technology, and Societal issues," or S-STS. This teaching method strives to teach science and current technological issues by integrating them with a social theme and introducing material from different subjects (science, mathematics, health, social studies, and social science) on a "need to know" basis. Our project involves the development and field-testing of an S-STS curriculum using a health thematic pertaining to the growing nationwide concern about students carrying increasingly heavy backpacks.

The heavy backpacks that elementary and middle school students carry has been gaining nationwide attention as the number of students reporting to chiropractors and medical practitioners for back pain and posture problems has been on the rise. Physicians have stated that students should not carry more than 15% of their body weight on their backpacks, but due to weight of heavy hardcover textbooks, younger students (4^{th} to 8^{th} grade) often exceed this recommendation. Coupled with the fact that students usually carry their backpack on one shoulder, this situation has the potential to create life long health problems for students.

This social theme allows the integration of several subjects to be taught in the curriculum along with raising consciousness about an issue directly relevant to students' lives. The S-STS curriculum that was designed included subjects such as biological science (muscles of the back, parts of the vertebral column), physical science (vectors, forces, Newton's Three

Laws), health (nutrition for building stronger bones and muscles, exercises, scoliosis) and mathematics (experimental design, data acquisition, statistical analysis) while connecting these diverse subjects to the common theme of backpack weight and its surprisingly far reaching implications. Since the central social theme which the curriculum revolved around was very pertinent to students' lives, it was anticipated that students would take an interest in the curriculum but we did not want to make the core issue too spectacular. Past WPI students who have designed an S-STS curriculum around health topics have generally chosen massive problems involving scary things ("dread" diseases such as Alzheimer's and skin cancer), which have met with minimal success. This is probably due to the psychological barriers thrown up by the students rather than the complexity of the material. Since the heavy weight of backpacks is not a fatal or incurable disease, it was a good way to test this theory. We anticipated that this curriculum would meet with more success because it avoided the "dread" factor.

The goal of this Interactive Qualifying Project was to develop, implement, and evaluate an S-STS curriculum which revolved around the aforementioned theme. This four-week curriculum unit was field tested in a health class setting at North High School which consisted of ninth and tenth grade students. This was not an ideal test group, since the heavy weight of backpacks is a greater concern for 4^{th}-8^{th} grade students. We asked for younger students, but this was the teacher who wanted most to work with us. The goals for this curriculum were as follows: to introduce some "serious" science education into a health class and make it interdisiplinary, show that the S-STS will involve more students in class participation and more effectively deliver in science and mathematics content. In order to do this with a health thematic, we had to prove that the off putting aspect of "disease" themes could be avoided.

It was anticipated that the S-STS style of teaching would result in an increase in the enjoyment of science and mathematics and that the central theme dealing with a relevant health concern to the students *at this time* would result in an overall increase in interest in the entire curriculum unit. The unit was evaluated using data acquired from tests, homework, presentations, pre- and post-questionnaires, a learning style measure called the MBTI, and other observational data. We would teach the unit ourselves.

The results of our analysis brought us to the conclusion that the S-STS curriculum that was developed was successful, but it had not found its ideal audience as of yet. Students in the health class at North High School acquired a lot of information during the four-week period in which the curriculum was taught as seen from the pre- and post-examinations. During this time, students learned complex subjects such as physiology, mathematics, and physics in a health class, something they were not used to doing in this kind of class and to which there was a mixed reaction. However, heavy backpack weights are not a serious issue for students in grades nine and ten (they have already hit puberty and have grown sufficiently to support the weight of textbook filled backpacks). Hence, the relevance of the unit was undercut. Further, the students in the health class in which this curriculum was taught were from the general student body and not from honors classes, and hence in this time and place did not carry backpacks as a matter of principle. We came to suspect that some students in our class truly had no need for one due to the great rarity with which they took any books home to do homework. Therefore, enthusiasm by the students for the curriculum was not as high as expected. We were told that in an honors science class the attitude might have been quite different.

Although the 9th grade students weren't as enthusiastic about the central theme as anticipated, the middle school children in the study (whom are at the highest risk for this problem) were extremely interested in the issue. Backpack and student weights were collected from Worcester East Middle School students and the resulting data set was used in the S-STS curriculum to introduce mathematical concepts. While collecting survey and physical data, we noticed a marked enthusiasm for our project, with many of these younger students expressing their opinions about how they feel about their backpack weights. They wanted to see the results as soon as possible. This experience has led us to believe that the S-STS curriculum developed would receive an enthusiastic response in a middle school setting, and serve to do some screening work as well. Of course, that was our original request and plan as well, institutional politics put us in a less than ideal study site.

We are claiming success with this unit based on the fact that relatively disinterested ninth grade students still learned about mathematics, physiology, and physics, all subjects that are rarely part of the ninth grade health curriculum, though they might be covered later in other classes. We soon found that this was not a rehash of familiar materials; they clearly did not know this material at the onset. On the other hand, the theme that we felt would invigorate the class was not a hit. The class still mastered new and important materials they had not thought about before, clearly an accomplishment, but the extra enthusiasm generated by relevant STS topics that other groups have reported was missing. The class did not go badly. The expectation and standards were raised, and ten of the thirteen initially quiet and shy students started to open up and participate in the class on a daily basis.

The curriculum that was developed also showed sufficient promise that the teacher wanted to see it used with a "real" science class capable of doing it justice. We too feel that it was field-tested in the wrong setting, but not that it was in the wrong level or kind of class. It need not be honors level physics or biology. It is likely to be just fine in a 7th or 8th grade science or health class where the children will respond to it as immediately relevant to them. In the right setting this would be a true S-STS class. Hence, we recommend a second field test with the audience we originally requested and have high confidence that the unit will be a hit, as it will be relevant, a true S-STS unit, as it was intended to be. A health problem but not a dread disease that affects the group studying it by studying themselves and comparing their data to the sample we collected at Worcester East Middle School, and have added to the unit after its 9th grade field test.

Chapter Two: Background

2.1: The S-STS Curriculum

In the late 1970's Rustum Roy and Leonard Waks of the Pennsylvania State University STS program, noted a lack of interest in the sciences and technology by public school children (especially those in high school) and thought they were in a good position to rectify this problem. They developed an integrated way to teach science, mathematics and social studies, known as teaching Science through Science, Technology, and Societal Issues, or S-STS curriculum. The premise of S-STS was that subjects such as science and math were better taught within the framework of social issues that students might encounter as society and technology issues. These would be more interesting due to the social context, so they were more likely to respond to them, and remember the science that elucidated the social issue. It was pretty well known that the natural curiosity in the physical world characteristic of 4^{th} to 6^{th} grade children dwindles thereafter as most students refocus their attention on social issues in secondary school.

Traditional methods of teaching school subjects are extremely abstract and textbook oriented, and tend to keep subjects such science, health, and mathematics distinctly separate. As a result, students receive a disjointed, rather than holistic, view of these subjects, with little insight and visualization as to how these subjects could be used in combination to solve social and technical problems that affect themselves and others.

Students who are not naturally inclined toward the sciences are the ones to suffer the most from the traditional approach. These students are not intrinsically motivated to learn science so the appeal has to be through the utility of these concepts (their "relevance"). Since these students are not taught that the scientific problems needing to be solved in the "real world" derive from social problems and tradeoffs involving a variety of subjects (some of which may have been of interest to them) they do not tune in immediately and engage the science until they make such a connection. In a traditional science curriculum, a science topic is first introduced conceptually and the relevant illustrative material supporting it would be introduced later as an application. The social ramifications of the science in the curriculum could be studied in some detail as multiple applications, but more often than not teachers run out of time before delving into even one application thoroughly. When they do get to the application, they often find that students cannot recall the abstractions covered at the outset well enough to apply them and need a review to do even one application of the main concepts.

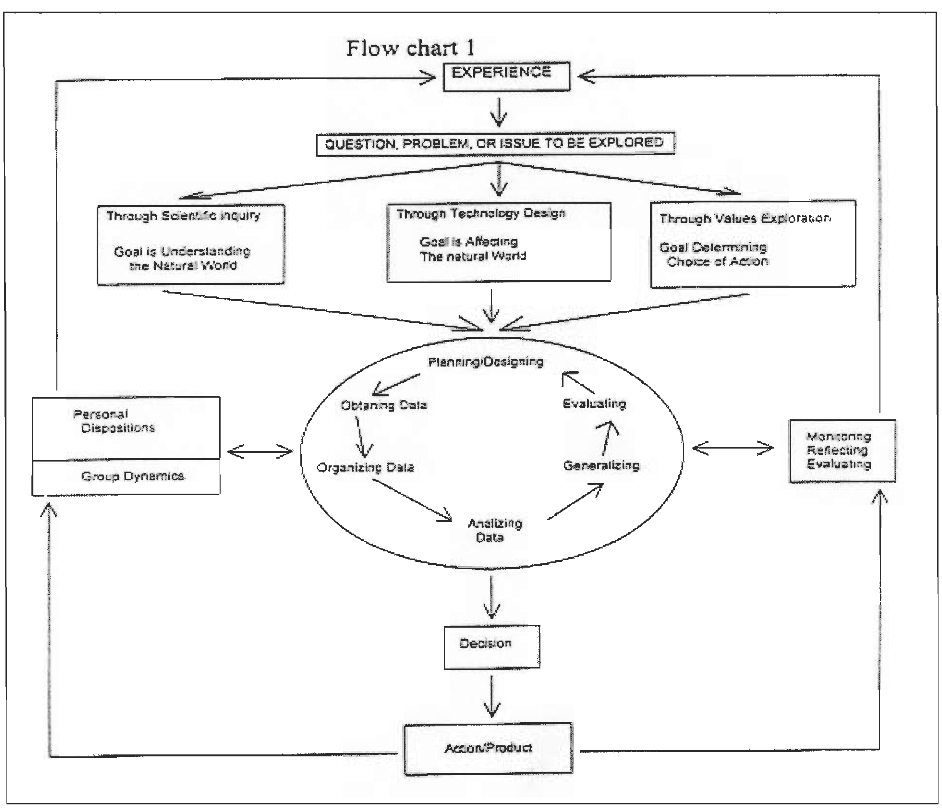
In contrast to the traditional curriculum, an S-STS unit revolves around a central sociotechnical theme (usually a topic that has direct relevance to the lives of students) around which lessons are planned. Hence, the question of why the technical material is worth studying is pre-empted, and never comes up. These lessons combine and integrate all subjects to help students understand and analyze the social issue/problem. An S-STS curriculum tends to rely heavily on student interaction. Many of the lessons involve debates, group activities, presentations etcetera. Please see Table 2.1.1 for further comparisons between a traditional and a S-STS curriculum (table was extracted from Robert Yager's "The Advantages of STS Approaches in Science Instruction in Grades Four Through Nine", Bulletin of Science and Technology in Society 13, 1993: 74-82).

The S-STS curriculum used for this project was organized using a method called the Umbrella Concept, which was developed by Keagle (Keagle and Syrigos, 1994). Under this method, each unit revolves around a social issue or problem over which the entire unit and lessons relate to. The Umbrella Concept was based on the "Emerging Generics of an STS Module" flowchart seen on the next page **(1)**:

Table 2.1.1

S-STS	Traditional
• Student-centered	• Teacher-centered
• Individualized and personalized, recognizing student diversity	• Group instruction geared for average student
• Directed by student questions and experiences	• Directed by the textbook
• Uses a variety of resources	• Uses basic textbook almost exclusively
• Cooperative work on problems and issues	• Students are seen as recipients of instruction
• Students are considered active contributors to instruction	• Some group work, primarily in the laboratory
• Teachers build on student experiences, assuming that students learn best from their own experiences	• Teachers do not build students' experiences, assuming that students learn more effectively by being presented with organized, easy-to-grasp information
• Teachers plan their teaching around problems and current issues	• Teachers plan their teaching from the prescribed curriculum guide and textbook.

Flow Chart 2.1.1



As seen above, the Umbrella Concept consists of four components, the first of which is the Broader Social Issue or Problem. This issue is the unifying theme throughout the lessons and should be of direct relevance to the students to capture their attention. The social issue need not have a right or wrong answer; in fact, it need not have an answer at all provided it lays a platform for many ideas to be discussed.

The Socially Oriented Question (SOQ) portion of the flow chart represents further social topics that are introduced in lessons that are related to the broader Social Issue or Problem. Each SOQ should promote group activity and student participation while aiming to foster social awareness and recapture student interest.

The third component of the Umbrella Concept as seen on the flow chart is the Lesson Material, which is chosen in correlation with the Broader Social Issue. This material should primarily consist of facts that should not be given to the students either verbatim or on the blackboard, but rather in an interactive manner. It is the teacher's responsibility to present this material to the students in the appropriate manner and at the time they become relevant so that the students have a "need to know" introduction to them.

The final section of the Umbrella Concept is titled Student Response to Socially Oriented Question, which is designed to stimulate a response to the Broader Issue or to a SOQ. This component of the concept may assume the form of a debate, presentation, local action initiative, role-playing game etc., and is designed to allow students integrate and utilize, practice and express all the information they have accumulated.

It must be noted that the concept of the S-STS curriculum has flaws according to critics in the science education community. Critics of the S-STS approach maintain that bringing in social studies (by introducing social consequences) into a science classroom reduces the amount of science content that can be covered in the available time. Another argument against this style of teaching is that the scientific and mathematical concepts that students learn remain selectively connected to the social issue/problem that was discussed rather than having their general value and range of potential application appreciated. Many students are unable to apply these concepts to other problems or real-life applications right away. By failing to generalize their knowledge immediately they might forget the concept before they fully appreciate it. Yet another drawback to this style of teaching is that it is extremely difficult for teachers and education professionals alike to evaluate how successful a unit has been in an objective way. A test of "factual" retention alone is not consistent with its goals; though retention tends to be good, it's transfer to other contexts that seems to be delayed and hence immediate factual test evaluations can miss it entirely.

Despite these criticisms of S-STS curricula, STS has met with success in stimulating more interest in subject material, extending student's attention span for science and technology, and retaining information for a longer period. Advocates claim that it does stick with students long enough to generalize by connecting with later experiences. S-STS curricula have been successful in demonstrating the relevance of science and mathematics to students' lives as well.

Yager's evaluation studies indicate that the teaching of facts is not better (nor worse) when STS is compared with the traditional approach, but on five other dimensions ranging from creativity enhancement to perceived significance of science to the students, S-STS courses were superior (Yager). Several prior WPI teams have puzzled over the factual findings wondering why greater interest, engagement, and retention was not resulting in better learning on the factual level as measured by factual tests. They concluded that Yager failed to enforce a key tenet of STS on all of the teacher trainees in his study; he let them decide what order of material to use rather than insisting that the social issue come first to provide a context for learning the technical material. Several WPI comparative studies (such as the Electricity and Acid Rain Units) in which this feature was strictly enforced, (they matched S-STS and traditional units with the same content) demonstrated that higher test scores (and presumably increased factual gain) were produced by the S-STS unit. When the identical test is given at the end of the units in both the S-STS and traditional classes, and the only thing that changed was the order of material one can be pretty sure that the S-STS format is the critical variable and does enhance objective factual learning as well as the other matters covered by Yager.

The main exceptions to this pattern of success over a series of ten unit studies were the two units that dealt with dread diseases as a thematic. The 9th grade Alzhiemers unit and the 6th grade skin cancer S-STS unit were unsuccessful, and in the 6th grade unit where the traditional approach was also tried in one of the classes, the students who did not know where the unit was going before they learned the basic concepts did noticeably better than those in the S-STS setting where they felt out of their depth knowing on day one that they were studying cancer. How could they be expected to understand the incurable and terrible disease if the grown-ups didn't even know what to do about this problem?

The fact that the focus of both the skin cancer units was on how to reduce personal risk did not help. They were overwhelmed, put off, had their excuse in place, and consequently the lessons did not go as well. By contrast, the students who learned their cell biology first, did labs, learned about structure and process, and later got the word about the subject, initially pulled back but then when the material was repeated (reviewed) in the context of cancer got a kick out of being able to understand the "hows" and "whys". They were so pleased with themselves they were ready to hear about risk reduction when that point was reached. The traditional class did much better on the final test. The purpose of this project is to delve into the special challenge of using health and disease topics as a thematic in an S-STS unit given the risk of having the students throw up barriers due to psychology of fear and dread associated with certain symbolic or loaded thematics.

2.2: Myer-Briggs Type Indicator (MBTI)

As mentioned in 2.1, the S-STS style of teaching, although quite successful, does cause some difficulty for the evaluation team. One feature of the more successful prior WPI evaluation studies involved classifying the students by learning style. Since the S-STS approach is highly interactive in terms of subject matter stressing social and environmental consequences it adds complexity and can get cluttered and thus harder for linear thinkers to follow and understand. The classification system for learning styles used for this study (and most other studies at Worcester Polytechnic Institute) is the MBTI (Myers Briggs Type Indicator) for students in the 9th-12th grade, or the MMTIC for students in the 3rd to 8th grade.

The Myers-Briggs Type Indicator® was designed by the mother-daughter team of Katharine Briggs and Isabel Briggs-Myers to designate one's personality type based upon a personality classification scheme developed by Carl Jung. Myer's and Brigg's scheme consists of four basic scales and two types within each scale, making sixteen Myers-Briggs types possible. Jung's theory had three dimensions. He proposed that people at all times are best understood in terms of several dichotomies involving how they relate to the world, namely: *extroversion/introversion, sensation/intuition,* and *objective/subjective.* The latter category was subdivided by Myers and Briggs into two variables*: feeling/thinking*, and *perceiving/judging.* Please see Table 2.2.1 for a description of these categories.

Throughout various studies done at W.P.I, it has been noticed that certain "types" of students respond to and perform better with an S-STS curriculum than others. These students have been characterized as ESFP (Extroverted, Sensing, Feeling, and Perceptive) according to the MBTI. Since the S-STS curriculum is highly interactive involving interactions with students and teachers, it follows that extroverts (those who are energized by other people), would most thrive in this environment. Both Sensing and Intuitive students appear to do well in an S-STS curriculum, although Intuitive students do equally well in a strong traditional curriculum as well. However, the Feeling students seem to get a lot out of STS as it starts with the question of how people will be affected, just the one such people prefer to use in making decisions. It motivates them to delve into the somewhat difficult technical material to follow to be clear why this is worth knowing up front. Compared to the structure of a traditional science unit, an S-STS unit can seem random since material is introduced on a "need to know" basis, driven by the issue rather than in terms of familiar and related concepts organized based on methodological criteria. Judgment types, or "J's" like structured and orderly presentations, while Perception types, or "P's" are indifferent to this and don't need to think about things sequentially to avoid confusion. The "just in time" approach to introducing ideas work for P's, whereas this approach may appear to be chaotic or jumbled to J's. Hence, ESFP's and ENFJ's are in sync with STS. However, the STJ combination, anointed with the logical and literal pragmatists, also can relate to a well organized STS unit, since it serves them well by motivating the unit "upfront": why this material is worth looking into and does so at the beginning of the unit, not at the end.

The S-STS learning style has been implemented in curriculum units by WPI students for about ten years now, and many of the project teams have used the MBTI (or the children's version called the Murphy-Meisgeier Type Indicator for Children, or MMTIC) as part of the evaluation procedure. Perhaps this common thread of profiling classes has persisted since it makes the S-STS curriculum easier to evaluate, as you can see which types of learners are hardest to reach using traditional units and calibrate the appeal of the S-STS unit in terms of how much it broadens the audience for science by seeing how they respond to the new unit.

Table 2.2.2

Action	Description of Preference
How a person is "energized."	Do you get your "energy" from within yourself or from outside yourself? If you are more likely to be energized by ideas, emotions or personal impressions, you are said to be an "*I*"--a person whose energizing is characterized by *Introversion*. On the other hand, if you are more likely to be energized by people, activities or things, you are said to be an "*E*" for *Extroversion*.
How a person "attends."	Do you have a preference for taking in information through the five senses and for noticing what is actual? Then you are an "*S*." If you prefer to rely on unconscious perceiving or intuition, and focus on the possibilities then you are an "*N*."
How a person "decides."	Do you make prefer to make decisions in a logical, impersonal, objective way based on abstract principles? If so, then you are a "*T*" (for "thinking"). If, on the other hand, you prefer to make decisions that take into account personal feelings, desires of those affected, and are value based, then you are an "*F*" (for "feeling").
Scale of "Living."	Do you have a preference for living a planned and organized life? Do you gather information for its on sake or for a purpose? If so, you are a J (for "judgment"). On the other hand, if you prefer spontaneity and flexibility, then you are a P (for "perception").

However, the policy issue involved is one of the tradeoffs. Does the S-STS unit succeed in reaching more students at the expense of those who are "naturals" for science as it is traditionally presented or does it increase the pool of science literate people while serving the "naturals" equally well?

The Science community is heavily INT (P or J doesn't seem to matter). The elementary teacher corps is heavily ESFJ. Hence, developing science units for elementary education is at once an effort to communicate with ones' opposite and reach ones future replacements through them. The evidence for and against STS is therefore context dependent and sometimes seems inconsistent.

In the 6^{th} grade studies, the WPI S-STS units are not just a first contact with S-STS, they are all too often the first units the typical elementary teacher has ever seen that are "natural" for them and rich with content. The teachers warm up to science and the whole class is transformed, everyone is drawn in. The NT and NF students are getting "good" science and shift from B's to A's, but it is the SF students who are the ones that make dramatic two grade level leaps in performance from the cellar to the second floor (D to B and C to A) in response to S-STS materials. There seems to be no tradeoff in this context. When it is the first "good" science class, everyone wins **(Gunnan & Klevens, Power Line Safety Study, W.P.I)**

It is in the secondary schools that evidence of a tradeoff appears. S-STS units have been known to "turnoff" the students who were the stars in the strong traditional program taught by specialists. To be precise, the evidence is more mixed, but so is the faculty more mixed by psychological type, as a balance is reached between the tendency toward ESFJ elementary school faculty and the tendency toward INTP science faculty at the college level. The secondary school faculty in science is a group of specialists, but it is not expected that they will do research, so a diverse collection of education educators is present.

The fate of S-STS curricula, such as ChemCom, created by the American Chemical Society, ACS, in their hands is highly variable. Some teachers like it and convey this to the students, and some do not, and also telegraph their feelings to the students, especially to "like type" students who can "read" them effortlessly.

Further, by this time the students are being sorted based on likelihood that they will go on to study science as a major at the college level into AP, honors, college, and general courses in each scientific field. It is not surprising that the cognitive mix in these classes is shifting along with the level of "challenge" in the program. Further, the "type" of teacher most likely to be teaching the course is also fairly predictable, with AP teachers especially likely to be INTJ's.

Our studies of response to "ChemCom" indicate that a 60%-40% split among the students (in favor of ChemCom) is usual. However, the science faculty considers it suitable only for "college" courses, designed for students going to college but unlikely to major in science. These classes are disproportionately populated with ESF students (since the sciences attract INT's), and the curriculum works with them. Actually, there is no reason to believe that S-STS science units steadily taught in the honors or AP level courses would not have "worked" for these ESF's too. The INT's don't consider them "science material" but they have an understandably biased reference point.

. A sample of student created and field tested STS-S projects is given in Table 2.2.2 below. MBTI, MMTIC, and MMTIC-r data that has been collected from some of these projects has also been arranged in this table, thus, creating profiles of the classes that have been studied. This allows a basis to compare the results of the STS curriculum unit studies.

Table 2.2.2

	E vs. I Extrovert/Introvert	S vs. N Sensing/Intuitive	T vs. F Thinking/ Feeling	J vs. P Judging/Perceiving	Unit
Normative Sample	74%/26%	57%/43%	20%/80%	34%/66%	
***Doherty H.S.**					
9th	82%/18%	54%/46%	42%/58%	14%/86%	Bronze
***North H.S.**					
9th/10th	**75%/25%**	**67%/33%**	**42%/58%**	**17%/83%**	**Backpack**
Oakham					
5th	78%/22%	39%/61%	5%/95%	5%/95%	Quabbin
6th	94%/6%	7%/93%	6%/94%	25%/75%	Bronze
Flagg St.					
6th	68%/32%	53%/47%	22%/78%	15%/85%	Nuclear Power
Greendale					
C-1 6th	63%/37%	71%/29%	21%/79%	8%/92%	Electricity
D-1 6th	65%/35%	43%/57%	9%/91%	22%/78%	Electricity
C-2 6th	90%/10%	40%/60%	10%/90%	30%/70%	Acid Rain 2
D-2 6th	75%/25%	50%/50%	15%/85%	20%/80%	Acid Rain 2
Belmont					
B 6th	86%/14%	64%/36%	14%/86%	50%/50%	Acid Rain 1
O 6th	84%/16%	84%/16%	21%/79%	32%/68%	Ozone
Millbury					
4th	79%/21%	63%/37%	18%/82%	33%/76%	Quinsigamond
May					
2nd	61%/39%	33%/67%	6%/94%	22%/78%	Recycling
6th	80%/20%	43%/57%	20%/80%	93%/7%	Nuclear
Downing					
6th	94%/6%	56%/44%	31%/69%	69%/31%	Space
Nelson Place					
0-1 6th	74%/26%	61%/39%	13%/87%	13%/87%	Ozone
0-2 6th	85%/15%	25%/75%	12%/88%	12%/88%	Ozone
Gates Lane					
4th	82%/18%	36%/64%	9%/91%	36%/64%	Intro. Literature
5th	81%/19%	48%/52%	17%/83%	33%/67%	Intro. Literature
6th	76%/24%	56%/44%	17%/83%	27%/73%	Intro. Literature
Center School					
5th	72%/28%	51%/49%	6%/94%	23%/77%	Weather
Nashoba					
9th	62%/38%	53%/47%	42%/58%	42%/58%	Nuclear Power
***Lancaster**					
8th	79.1%/20.9%	51.2%/48.8%	51.2%/48.8%	32.6%/67.4%	Nuclear Power
8th	75.4%/24.6%	31.4%/68.9%	24.2%/75.8%	7.8%/92.2%	MBTI Study
***Bolton**					

8th	80.6%/19.4%	17.2%/82.8%	3.6%/96.4%	24.1%/75.9%	MBTI Study
***Stow**					
8th	76.7%/23.3%	33.3%/66.7%	34.5%/65.5%	25.9%/74.1%	MBTI Study
***Leicester**					
11th	61%/39%	54%/46%	56%/44%	28%/72%	PSAT Study
***Fitchburg**					
11th	55%/45%	54%/46%	50%/50%	30%/70%	PSAT Study

* Used MBTI

2.3: North High School Background

The backpack S-STS curriculum was taught as a health class at North High School in Worcester MA., the second largest city in New England. Worcester is predominately a working-class city though the range is from lower to middle class residents. Situated on Harrington Way, North High School is one of four high schools in Worcester and serves one of the less affluent areas of the city. The student body is ethnically diverse and largely working class with a majority of students coming from single parent homes.

As seen from Table 2.3.1, about fifty percent of the student body is of African American, Asian, and Hispanic descent, which is only slightly greater than the district, but substantially greater than the state average. There are 17.5% more Hispanic students and about 7% more Asian students in attendance at North High School in comparison to the state of Massachusetts. The percent of student's not proficient in the English language is slightly lower at North High School as compared to the area, thus explaining the school's limited number of "English as a second language" classes.

Table 2.3.1

Race/Ethnicity, 1998-9 (%)

	School	District	State
African American	11.0	10.0	8.6
Asian	11.0	7.1	4.2
Hispanic	27.5	27.6	10.0
Native American	0.3	0.5	0.2
White	50.1	54.8	77.1

Selected Populations, 1998-9 (%)

	School	District	State
Limited English proficient	4.3	7.0	4.7

The school's average verbal and math scores on the SAT for 1999 falls about 15% and 16% below those of the nation respectively (please see Table 2.3.2 below). Despite slightly lower SAT scores, the percent of students who take the SATs (thereby indicating an intention to go to college), was 9% higher than the nation in 1995. However, compared to the state of Massachusetts, 10% fewer students took the SATs at North High School in 1995 than is typical of the state.

In the 1997-98 school year, 43.5% of the student body planned on attending a four-year college, which is again 10% lower than for the state. Two-year colleges appeared to be a popular option during this school year, with approximately 28% of the class planning to attend one. As compared to other students in the Worcester district, 4% more of the student body planned to work directly after high school in the 97-98 school year (please see Table 2.3.3). The dropout rate at North High School was also larger than that of the state in the same school year, although it was substantially lower than the year before. In short, this was a school where motivation to study at all, much less study science, could not be taken for granted.

Table 2.3.2

SAT	**Verbal**		**Math**		**Partic. Rate**	
	1995	**1999**	**1995**	**1999**	**1995**	**1999**
School	421	426	446	425	45%	55%
District	448	452	449	452	57%	47%
State	498	504	498	505	67%	68%
Nation	501	502	504	508	36%	N/A

Table 2.3.3

Attendance Rate (%)	88.7	93.5	93.9
Student Exclusions (#)	14	119	1,334
Plans of High School Graduates (%) (North High School)			
Four-year College	43.5	48.7	53.2
Two-Year College	26.8	29.3	18.6
Work	14.5	10.6	16.2

Table 2.3.4

1997-1998	**School**	**District**	**State**
Annual Dropout Rate, Grades 9-12 (%)	7.3	5.9	3.4
Dropout Rate, 1996-7	12.4	7.9	3.6

Specifically, the S-STS curriculum we designed was taught at North High School in a health class. At North High, two health classes are mandatory for graduation, and most students take these classes during their freshman and sophomore years. There are no set curriculum guidelines or "frameworks" for these classes as there are in English, Science, and other subjects covered by the state assessment, called the MCAS exam. Rather the regulations state that certain topics such as nutrition, puberty, and various adolescent concerns such as weight should be covered. Since the S-STS unit designed covered such topics as nutrition, scoliosis, and proper exercising techniques, it was thought by administrators that a health class would be a good place for the 3-4 week curriculum unit. The fact that the experiment would not cut into MCAS preparation time this way was considered an advantage. This decision was less than ideal from our stand point. Being in the health curriculum was fine, but we had a younger group of students, preferably in middle school, in mind when we proposed the topic.

Although health class is mandatory for all students at North High School, there are certain elective classes such as Advanced Healthcare and a special program with the Ecotarium for students who are more interested in the sciences and are more medically inclined. Topics in Advanced Healthcare cover cancer, the latest research techniques, CPR, anatomy and physiology, etc. and the program with the nearby Ecotarium allows students the opportunity to conduct experiments such as water testing. These two elective classes follow their own curriculum and provide a medium where medically and science oriented students may thrive. Hence, we would have the average students who were not taking advantage of any other of these special programs in our class. This is appropriate as S-STS is in part an effort to motivate science and make it meaningful to just such students for whom interest cannot be assumed and literacy at the level appropriate to the citizen, rather than preparation to enter science or medicine as a profession, is the goal of science education.

2.4: Backpacks and Back Pain in Adolescents: A Growing Social Concern

During the past decade, medical professionals have reported an increase in the number of student complaints regarding back, neck, and shoulder pain linked to backpacks overloaded with books. The U.S. Consumer Product Safety Commission reported that about 240 children were treated in hospital emergency rooms in 1997 for back strain or sprains after carrying backpacks. Heavy backpacks can be particularly troublesome for children who have scoliosis, a lateral curvature of the spine, aggravating the condition. Scoliosis is curable if detected and attended to early.

Students these days are said to be carrying up to forty percent of their body weight back and forth from school to home these days; a load that would stagger most adults. Backpack Safety America warns that this kind of excess weight can strain muscles and lead to a lifetime of health and postural problems for these kids. Of course, the younger students with less weight are most at risk since their books are often no lighter nor less numerous than those given to older students.

The spine consists of a stack of bones, or vertebrae, with disks located between each layer. Since there is no fundamental structural stability in the spinal column, posture is controlled solely by the surrounding muscles. The spines of younger children are especially susceptible to backpack-related injuries because they do not have the well-developed muscles and spinal control found in teenagers and adults. Dr. Griffin, assistant professor of pediatrics at Meharry Medical College, states that, "Particularly during adolescence, a lot of kids are getting into the postural position of forward shoulders and head." "That's kind of the age where they're a little more body conscious and if they are using the backpack with an extreme load, that accentuates this bad posture," she says. "It's making them go more forward ... just to hold the backpack"

Experts claim that this increase in backpack weight is recent and may be attributed to many factors. Over the years, class and homework have become more extensive and the weight of textbooks has increasingly gotten heavier. Publishers of many textbooks now include material for different classes within the same book (for example, the material for Algebra I and Algebra II may be in the same book). Schools tend to buy these larger, hardcover books since they cost less money in the end. Another factor that increases backpack weight for students is that many kids also need equipment or clothes for various after-school activities and sports.

While the weight of the backpack is increasing, many schools are increasingly restricting locker usage by students resulting in students carrying heavier loads for a longer period. Many schools are eliminating lockers for security reasons. Others schedule classes so tightly that students can not get to their lockers in time to switch textbooks or else schools have strict regulations about when students may have access to their lockers. The net result is that kids are probably carrying a heavier burden than before.

Pediatricians have suggested a variety of methods to reduce the risk of injury and minimize posture problems due to heavy backpacks.

Figure 2.4.1

- Backpack should be worn over both shoulders. Carrying a backpack on one shoulder causes an asymmetry of gait, or lopsidedness.
- Straps should be tightened so the backpack fits snuggly. Worn loosely, they can double the pressure put on the back.
- Choosing a style of backpack that has wide, padded shoulder straps so sharp corners do not poke into the back.

- A hip belt to distribute more weight to the pelvis and hips, rather than relying on the shoulders to endure most of the load.

- Positioning the backpack so it rests between the shoulder blades and is centered in the middle back.

Correctly packing backpacks so that weight is evenly distributed is also of vital importance in the maintenance of good posture and a healthy back. Below are some tips on carrying the maximum amount of weight correctly.

Figure 2.4.2

- Consider a child's individual muscular development, in addition to their size, when determining a safe weight range.

- Pack light. The backpack should never weigh more than 20 percent of the child's body weight.

- Distribute weight evenly. Using all of the pack's compartments can help.

- Pack heavier items closest to the back so the center of gravity is near the center of the pelvis.

In addition to students following the aforementioned tips, this growing trend of back pain and bad posture may be alleviated with the help of government and school officials. With an increasing number of classrooms and households alike containing one or more computer, CDROMS rather than books may be given to the students, thus reducing the load of backpacks. Another, more expensive option is to issue two sets of books to the student, one that they may keep in their lockers and the other at home. Assigning additional locker space allocated to those students with extracurricular sports activities may also help the situation. Therefore, students may keep their sports equipment and change of clothing in their lockers at all times, removing the necessity of carrying them back and forth all the time.

Parents are also turning to backpacks on wheels for their children (commonly called the "Roller Backpack"), which are designed to be miniature suitcases. A problem with the Roller Backpack includes the larger size of these backpacks. They are difficult to store in lockers and clutter school hallways, thus making them a safety hazard. Roller backpacks can actually be detrimental to student's posture because they do not provide any support for the back as the regular backpack does. A lighter backpack, when carried properly on the back and not on one shoulder, can actually improve the posture of adolescents by keeping the student's shoulders back and head up if there is not too much weight.

2.5: The Backpack Social Issue as an STS Curriculum

The growing concern for student's health in regards to heavy backpacks makes it a good theme for an S-STS curriculum despite what may seem to be too limited a social impact. At first glance, it may appear that this issue falls solely in the public health category with little to no relevance with science, mathematics, or social studies. After all, it involves a growing concern for posture and back problems in adolescents due to a trend in backpack weight. However, this trend is tied to style of life and social and corporate policies.

Although traditionally this topic would have fallen under the health category since subject matters are kept separately in categories such as social studies, math, etcetera, it actually has great potential to combine several topics at once. Science topics such as anatomy and physiology are taught while explaining which muscles in the back are affected by carrying heavy loads, and how these muscles work to support correct posture. In addition to the "medical" aspect of science, the less obvious genre of physics can also be taught in this curriculum. Topics such as correct packing of the backpack and correct positioning of the backpack are studied in the light of Newton's forces and the center of gravity. Force diagrams that show the distribution of weight when carrying a backpack on one shoulder, two shoulders, and two shoulders with a hip belt are drawn to demonstrate scientifically *why* wearing a backpack on both shoulders is so important.

In addition to the sciences, various health topics are covered in this social issue. Proper nutrition to build strong bones so that a backpack may be carried easily and so that vertebrae may be stronger to support better posture, proper exercising to build strong back muscles, and discussion of scoliosis and its treatments are just a few of the topics that fall into this curriculum.

In addition to the science and health, mathematical and statistical concepts such as graphs, ratios, percentages, and data analysis are also taught and applied in this curriculum. A data set consisting of weight and height of a student, weight of backpack, ethnicity, and various other factors (please see Appendix A) was collected by the students themselves and analyzed using the aforementioned mathematical concepts. In addition to data analysis, the students also learned about experimental design and collecting data using a representative sample. Social studies issues (in terms of social science) were also broached in terms of comparing how people of different ethnicities react to pain in terms of expressing it when they are hurting or hiding it and being stoic.

Besides integrating subjects and teaching them on a "need to know" basis, the backpack S-STS curriculum also allows students to work with a design issue. As part of the curriculum, students will be analyzing current backpack designs and determining their "pros" and "cons" in terms of how well the backpack distributes weight, how sturdy and durable the material the backpack is etc. Students will then be asked to design their own backpacks keeping in mind the above criteria.

As seen above, the backpack S-STS curriculum has considerable promise and is clearly interdisciplinary, combining many subject matters in one comprehensive unit that is of relevance to students so that a more realistic presentation of science may be achieved. The question of "Why are we learning this?" should not come up, since this topic affects students themselves quite directly. We are studying to assess their relative exposure to a new risk factor.

The fact that heavy backpack weights are causing back pain and posture problems in students is one that students should be able to relate to, since they may have probably experienced a similar problem. Many students may have had occasional back pain as a result of heavy loads carried when they were younger, and by making this issue personal to the students, it sparks interest in the science that explains their experience and that of peers more heavily affected. Although the age group to which this curriculum had been taught was older than that most at risk for back problems associated with heavy backpacks, the unit still promised to be relevant. Many students had younger siblings or friends in the age group at risk, thus making this topic of importance to most of those involved in the study.

Other projects at Worcester Polytechnic Institute have developed S-STS curricula using science and/or health themes such as skin cancer and Alzheimer's. However, this project differs from other projects because it steps away from "dread" diseases and focuses on an issue with important, but not fatal, consequences to students. Heavy weight of backpacks is a topic that has already affected students or is affecting someone they know at present. The advantage this curriculum has over other "dread" curriculum is that it has less of a chance of scaring students away from the associated science with a sense of fear or hopelessness. The backpack curriculum gives students an opportunity to do something about this problem such as carrying their backpack differently, or writing to school and government officials about gaining more time for access to lockers. It is not outside of their still limited span of control.

Section 2.6: The Skin Cancer Unit vs. The Backpack Unit

As previously mentioned, past WPI project groups that have used a health thematic as the central social issue in their S-STS units have met with limited success. Many reasons have been hypothesized for this, the most prevalent being that these past groups have used so called "dead" diseases. One such example of this is the skin cancer S-STS unit called "Tans Aren't So Healthy Anymore", designed by Corena Atkins and Jeffrey Roberts in 1997. This unit was field tested in 6th grade classrooms at Tatnuck Magnet School (where the students taught the curriculum) and May Street School (where the regular science teacher taught the curriculum) in Worcester. The unit was taught in both the traditional manner and the S-STS style at both these local elementary schools, and to the authors surprise, students in the traditional classrooms did much better than those in the S-STS style.

These results suggest that health thematics do not fare well with the S-STS approach, but we suspected that the results indicated something much deeper than this. In order to test this hypothesis, a list of reasons were made to explain why the skin cancer unit was not as successful as other S-STS curricula (other than the theory that health in general is not a good thematic to use in an S-STS unit). The backpack unit was designed to avoid these hypothesized problematic features, and thus if the backpack unit also failed the case that a health thematic cannot be taught well by the S-STS would have to be considered. If we succeeded with a health thematic then the problem was not generic.

There could have been many reasons why the skin cancer unit had such limited success, one being that skin cancer was not a topic that affected the students' daily lives right now. It was a disease that would strike as many as thirty years later, when they were "old", and even though the unit stressed that students could do things *right now* to prevent skin cancer, later the disease itself wasn't tangible and generated free-floating anxiety. In fact, in their report, the authors of the skin cancer unit even state, "...We thought the students would find skin cancer exciting and realize the importance of learning about it. Even the fact that 1 out of 10 children by the age of 18 will get skin cancer seemed to have little effect on the students. They enjoy playing out in the sun and would not want to give that up. Also, skin cancer is not something affecting them or anyone they know right now, so the students do not worry about it." In contrast, the backpack unit was designed to be directly relevant to the students' lives right then. Heavy backpacks is something they were thought to experience multiple times everyday, in the morning when they go to school and every afternoon when they come home, thus making the issue very tangible and real. Students would *know* that this is a problem, and be eager to find a solution for it so that they can relieve their burden, or so we thought.

Another factor that might have contributed to the decrease in enthusiasm for the skin cancer unit is that skin cancer is a potentially fatal disease that must sound very scary from the students' viewpoints. The term "cancer" (regardless of the type) brings to mind a deadly condition, one that is accompanied by a loss of strength, spirit, and power. Although the authors of the curriculum stressed that skin cancer could be prevented by precautions taken by the students now, this was not enough to overcome the "dread" issue. On the other hand, the backpack unit stresses that overweight backpacks can cause posture problems and backache, hardly conditions that inspire a feeling helplessness.

The authors cite one last reason to explain their results, and this is that the curriculum relied too heavily on content and not enough on connecting different topics (such as DNA, proteins, cells, etc.) to skin cancer. In the authors own words, "For the S-STS unit to be more successful, we feel the lesson plans would need to be carefully revised to make it more of a pure S-STS unit. Our unit focused on content rather than incorporating the social theme into every lesson. We were not able to do that because we needed to cover background material to get the students to that point and were not able to relate everything back to skin cancer directly. If we decided that we wanted to just focus on the idea of skin cancer and not get into how it is caused, we could have gone with a more pure S-STS approach." To avoid this problem, the backpack unit was designed so that each lesson that was taught (physics, physiology, mathematics etc.) could directly be tied into the backpack problem. These subjects were not taught in depth, rather only the amount necessary to understand the problems caused by heavy backpacks was taught.

With these changes, it is anticipated that the backpack unit will meet with greater success than the skin cancer unit. The backpack unit is designed to be directly relevant to the students lives (at this time) and something they will be able to control, thus increasing students interests.

Chapter Three: Methodology

3.1: Raising Social Awareness

As previously mentioned, there were two purposes for designing a curriculum that dealt with the growing social concern of the heavy backpack weights carried by students. The primary purpose, of course, was to present this information in the S-STS teaching format so that students could learn different subjects such as mathematics, science, and social sciences in an integrated and hopefully more relevant manner to students' lives.

A secondary purpose to this project was consciousness raising, to observe if the Backpack and Back Pain Curriculum brought about any social awareness of this problem within North High School. As mentioned, the backpack curriculum was taught to a health class composed of thirteen students of whom the majority were ninth graders. Since the social issue at the core of the curriculum affected these student's peers and younger siblings, we were interested in whether word of this issue spread throughout the North High community by word of mouth, originating from the health class.

The change in social awareness in the North High School community was measured using a method adopted from the Science Indicator Report of 1985. This report assumed that any social group consisted of two types of people, opinion leaders (around 10%) who pulled information in from various written and network sources and took stands on it, and followers, who were in the majority and tended to be less attentive to science and pick things up from the opinion leaders following these fields. In order for an increase in social awareness regarding the backpack issue to occur, the people in the health classroom where the curriculum was tested had serve as or already be opinion leaders.

In order to detect the change in social awareness, a survey that measured the scale of the "attentiveness" for science, health, and current events was created (see Appendix B). These surveys were distributed to ninth, tenth, eleventh, and twelfth grade classes at North High School both before and after the curriculum were taught. The survey was distributed to 100 total students, approximately 25 ninth, tenth, eleventh, and twelfth graders (one classroom for each grade) which were selected randomly with the assistance of the guidance office at North High School before the curriculum was taught. Unfortunately, the same number of surveys could not be obtained after the curriculum was taught, since the twelfth graders had graduated already and the eleventh graders had mostly finished classes, but the ninth and tenth grade post test surveys should be revealing.

The information obtained from the survey that was distributed first (before the curriculum) had two purposes. By determining how many students were already interested in health and science topics, it could be determined whether or not the backpack curriculum was a "good" thematic to use in this community. Past evidence gathered by similar indicators in national surveys has revealed that approximately 10% of the population is interested in foreign matters, 30% in science and technology (about one-third), and 50% in the economy. Whether the North High School community mimicked these predicted values and whether or not the school community was interested in health topics were both questions extremely relevant to this project, and were both answered by this survey. In addition, this survey also provided a reference to compare whether or not the attitude of the community changed in regards to health and science topics (specifically the backpack issue).

The same survey was administered after the curriculum was taught, and was used to determine whether the people in the health class served as opinion leaders and thus "spread the word" about the backpack problem. This survey also determined the level of attentiveness (their ability to pick up ideas) for the rest of the North High School community.

The surveys that were administered asked students' to quantify their interests in a variety of newspaper headings that addressed such topics as current events (both local and national), fashion, romance, business, computers, crime, religion sports, research science, and the health sciences. Students were asked to rate, on a scale of 1-16 with 1 being the most likely and 16 being the least likely, a list of newspaper headlines that they would be most likely to read. The newspaper headlines (which were fictional in content) were geared to address the aforementioned topics and evaluate whether the student's response changed at all before and after the curriculum.

In addition to being asked to rank newspaper headlines, students were also asked to rank how likely they were to read certain *topics* in newspapers or magazines on a scale of 1-15, with 1 being the most likely and 15 being the least likely. The purpose behind asking students to rank both newspaper headlines and newspaper topics, both of which addressed the similar issues of what topics students were most interested in reading before the course, and if their opinions changed after the course, was to serve as a check for one another. If both questions asked what was intended, student's responses for the two questions should be the same. For example, if a student indicated that they were most likely to read about "Best and Worst Dressed at the 2000 Grammy's" (item j. on question two of the survey), then they should have indicated that they were most likely to read "style and entertainment" (item f. on question three of the survey).

It was hypothesized that the surveys would show that about one-third of the North High School community would be attentive to the science/health topics as predicted by different indicators. The likelihood that this interest in health would increase after the unit was taught was slim, since the class size where the curriculum was taught was so small and the chance of having opinion leaders in the class was consequently low. However, if they were intrigued and went to the overall student leaders who then decided this is new matter was important their endorsement would influence the level of awareness exhibited by all those who follow their lead. . In short, it could happen at last within a class year on student cohort, probably 9th grade.

3.2: Contacting the School Systems

Before designing the S-STS curriculum, the first step in the project was to establish contact at a school system in the area. The reason why the school system was contacted before an actual curriculum was developed was that this way a feel for whether the schools were interested in the topic could be estimated. If no interest was expressed by the schools, it would be a worthless endeavor to develop a curriculum and a different social issue would have to be the curriculum focus. Another reason for contacting the school systems first was so that school teachers could have more of a voice in the subjects that were taught within the curriculum. Teachers were the best link regarding the level of difficulty of the curriculum and the feasibility of some activities within the curriculum.

Initially, project proposal levels were sent to four school districts; the Worcester, Shrewsbury, Leominster, and Nashoba public schools. The project proposal (please see Appendix C) was written explaining the reason for developing an S-STS curriculum, the social issue that the curriculum centered upon, and the various subjects the curriculum would address. To further stimulate the interest of school curriculum advisors, many of the subjects intended to be covered in the curriculum were modeled to fulfill subject requirements at the 9^{th} and 10^{th} grade level for MCAS testing. It was anticipated that this would make a school system more willing to give four weeks for the curriculum (four weeks that could be spent on topics that could help improve MCAS scores).

It was hypothesized that due to the pressure on most city public schools to raise MCAS examination scores, it would be difficult to obtain permission to teach the unit in science classes there. Rather, we expected that the suburban school systems would be more likely to allow the curriculum to be taught, since the average MCAS scores for the suburbs was higher than that of the city school systems. For this reason, it was surprising to find that the Worcester Public School System was the first to respond and the most eager to embrace the S-STS curriculum. They arranged for contact with Mrs. Jackie Letino, a health teacher at North High School where the curriculum was eventually taught. Hence, the issue was considered "health," not "science," by the system, therefore it would not cut into science time, but rather increase the time devoted science by putting serious science into the required health class.

The ease with which the S-STS curriculum was incorporated into the school curriculum may largely be explained by the perception that it was not really science. After speaking with Mrs. Jackie Letino, it became apparent that health classes in Worcester Public Schools have a very loosely defined health curriculum, which does not specify more than covering nutrition, sexuality, and eating disorders. The rest of the year's curriculum is left largely to the discretion of the health teacher, and thus there is a lot more room for "experimental" lessons.

Another factor contributing to the ease of incorporation into the health class is that health is not a subject that covered in the MCAS examinations. For this reason, it is easier for public schools to allow "non-traditional" and "experimental" lesson plans to be incorporated into the health curriculum without loosing valuable class time on subjects that *will* be tested on the MCAS such as mathematics, science, and social studies. So, this would be an "undercover" science class.

3.3: Designing the Curriculum for the MCAS

As mentioned, the S-STS curriculum unit design included many of the learning standards defined by the Massachusetts Science and Technology Curriculum Framework for 9th and 10th graders. These standards are the criteria for the questions on the Massachusetts Curriculum Assessment System (MCAS). The MCAS was implemented in response to the Education Reform Law of 1993, which required that the MCAS be designed to:

- Test all public school students across the Commonwealth, including students with disabilities and students with limited English proficiency.
- Be administered annually in at least grades 4, 8, and 10.
- Measure performance based on the Massachusetts Curriculum Framework learning standards.
- Report on the performance of individual students, schools, and districts.
- Serve as one basis of accountability for students, schools, and districts (for example, beginning with the class of 2003, grade 10 students must pass the MCAS tests as one condition of eligibility for earning a high school diploma. Students will be given multiple opportunities, if necessary, to pass the tests between grade 10 and the end of their senior year. In addition to passing the MCAS tests, students must also meet local requirements for high school graduation.)

Since the MCAS examinations have been implemented, school officials have been under tremendous pressure to improve students' test scores, which have fallen under direct attack and provoked public outrage. Some districts face the prospect of having 65-70% of their students fail. Consequently, school officials are working hard to incorporate in-depth lessons on the learning standards set by the Massachusetts Science and Technology Curriculum Framework, especially in large urban districts, like Worcester. While Worcester is doing marginally better on the exam than other cities, it still has two-thirds of its students at risk of not passing. Even the strongest districts in the state will have 15-20% at risk and a third of all the high school students in the state will probably not pass the first time.

For this reason, it was decided that the S-STS curriculum developed must contain many of the learning standards outlined in the curriculum framework if any Massachusetts district was to find time for it. Many of the topics, which included forces, data analysis and physiology, that were to be included into the curriculum had already been outlined, and upon viewing Strand 1 and Strand 2 of the curriculum framework, it was decided that the curriculum touch upon several of the topics outlined in the 9-10th grade standards.

Strand One of the framework is termed inquiry (found in Appendix D), and is primarily concerned with students exhibiting skills necessary for scientific inquiry, with the hope that upon graduating high school students should be able to "think like a scientist." These skills include the ability to form and design experiments to test hypothesis, to analyze data obtained from designed experiments, and the ability to present findings in a comprehensive and complete manner.

Under the 9-10th grade span of strand one, many of the learning standards were used in the S-STS curriculum developed. These included:

- **Use a range of exploratory techniques, e.g., experiments, information/literature searches, data logging, research, etc.**

  This learning technique is used in the S-STS curriculum when students are asked to determine if the heavy weight of backpacks is a problem in their high school community. Students are handed questionnaires (see Appendix A), and are told to conduct random samples from their peers, thus generating a database from their high school community, which includes information on whether students at their school feel their backpacks are heavy enough to cause them backache, how long students carry their backpacks, students' height, weight, and weight of their backpack, and other variables are also taken into account. This allows students to use the exploratory technique of field experimentation. Data logging will also be used by the students when it comes time to analyze the collected data.

Students will also use information searches and research during the assignment to create their own backpacks that will distribute weight better across the back. Students may use the World Wide Web to research existing backpack designs and the reason manufacturers used them, the concepts of cost management when designing the backpack (the best material to use versus the expense of the material), along with the overall "look" of the backpack (how appealing was it to consumers).

Literature searches will also be conducted by the students when preparing for their debate on whether universal scoliosis screening should continued in public schools given the few cases likely to be found. This research included finding the cost of scoliosis screening for schools, learning the potential hazards if scoliosis went undetected, and finding what are the determining criteria for classifying a medical condition as a public health risk.

- **Make decisions about the range and number of independent variables and how to control other variables in designing experiments. Select and use common and specialized tools to measure the dependent variable.**

  As students are analyzing the data they will have collected from their high school community, they will be asked to distinguish between independent (x-axis) and dependent (y-axis) variables. Students will be given a compiled list of all the data collected from all the questions on the questionnaires, and it will be up to them to pick two-three variables to study and analyze. For example, students may compare percent backpack to body weight (independent variable) versus experiencing back pain (dependent variable) and be asked to decide which the dependent and independent variable would be in this case. Since the students will be obtaining some of the data sets themselves, they will be collecting all the dependent variables either by distributing the questionnaire or by measuring the weights and heights of their peers.

- **Select appropriate methods of recording and interpreting data.**

  Before collecting the data samples, students will be given a lesson on experimental design, which will emphasize the importance of drawing a random sample if one wants to generalize the findings. The lesson will detail the errors that may occur in sampling studies, such as the data not being random, biases in the data, and non-response biases. Using this background, it is anticipated that students will be able to conceptualize and conduct a truly random sampling study that will accurately represent their school or assess the one we are likely to supply in the revised version of the unit.

Students will be asked to analyze the data they have obtained themselves, by using graphing (pie, bar, and scatter plot), percentages, mean, median, and mode. They will be using statistical calculators or Excel to analyze the data, and will draw conclusions based on their analysis.

- **Question interpretations or conclusions for which there is insufficient supporting evidence, and recognize that any conclusion can be challenged by further evidence.**

Students will be divided into groups of four when analyzing the data that will be collected by the class as a whole. For this reason, many groups may analyze the same set of independent and dependent variables, and arrive at different results since they will be using different techniques and grouping methods to analyze the same data. Thereby, students will learn important lessons such as the impact of such procedure decisions, that conclusions should be challenged, or at least not accepted blindly, and that multiple investigations and peer reviewers are helpful in ascertaining the pattern of evidence to be interpreted and examining the interpretation from several perspectives. Consensus is convincing only when it represents a diverse set of possibilities being fully explored and a convergence on the overall best explanation.

- **Formulate further testable hypotheses based on the knowledge and understanding generated.**

After students have analyzed the data they have collected, many questions are anticipated to arise in students' minds. If the data revealed that their school does not have a problem with heavy weights of backpacks, students should be able to form hypotheses as to why this might be the case. Conversely, they should be able to formulate testable explanations that might explain why their school has an unusually widespread problem with backpacks weighing too much. This mentality of constantly asking questions and never stopping just because a conclusion has been drawn is indicative of a scientist's mind, and the ability to think skeptically is something that should be practiced regularly by students.

Strand Two of the framework is termed domains of science, specifically physical sciences (found in Appendix D). This strand is primarily concerned with topics that should be covered in the science classes for different grade spans. Overall, the topics included in the 9-10 grade span include structure of matter, interaction of substances (chemical/physical changes), forces and motion, and conservation of transmission of energy.

Under the 9-10th grade span of strand two, the topic that was covered in the developed S-STS curriculum was forces and motion. Specifically, under the forces and motion topic, the following concepts were covered in the S-STS curriculum, as directed by the curriculum framework:

- **Demonstrate that all forces are vector quantities, having both magnitude and direction.** ***Explore ways in which forces acting in the same direction reinforce each other. Also, explore ways in which forces acting in different directions may detract from or cancel each other.***

Under the physics lesson used to demonstrate why backpacks should be worn on two shoulders rather than one, the concept of forces as vector quantities will be introduced to describe weight. It will be explained how weight (mass * acceleration due to gravity) is actually a force, and all forces are vectors with magnitude and direction. The "direction" component of weight stems from the acceleration due to gravity, which always points toward the center of the Earth.

The aforementioned concept will be used to help students draw force diagrams, a pictorial representation of all the forces acting on a particular object (in this case the backpack). With the help of the force diagram, students will be able to see that forces acting in the same direction are additive, and those acting in opposite directions are subtractive. This concept of additive and subtractive forces is key to understanding why wearing a backpack on two shoulders (subtractive forces distributing weight on both shoulders) is better than wearing it one shoulder (entire weight of bag distributed on one shoulder).

As seen above, the backpack S-STS unit was designed while keeping the topics put forth by the Massachusetts Curriculum Framework for ninth and tenth graders in mind. It was hypothesized that the S-STS unit would be more readily accepted into school systems since it would not "waste" valuable time that could be used to teach topics covered the MCAS.

3.4: Curriculum Development

The structure of a curriculum is fundamental to making information understandable, interesting, and important enough to learn. We decided to use the S-STS curriculum format. An S-STS curriculum thoroughly integrates the science, math, and health topics together to explain a social issue, which is of interest to students. In short, it motivates learning due to the way disparate information is brought together.

As mentioned earlier, the S-STS curriculum format we adopted was presented by WPI alumni, Brian Keagle and Yianni Syrigos (see Section 2.1 for details). They borrowed the "Umbrella Concept" from Leanord Waks of Pennsylvania State University who seem to have drawn on work by John Roeder, of the Horace Mann School in New York City. The first part of the Umbrella Concept calls for a broader social issue or problem that is used to teach and relate a variety of different subjects. Of course, the social issue in the curriculum we developed was the growing set of health concerns related to the increasing weight of student backpacks. This social issue had a direct and immediate relevance to the lives of secondary school students and their younger siblings as the heavy weight of backpacks is considered the major cause of a marked increase in the number of student complaints about back pain and the prevalence of poor posture.

The second part of the Umbrella Concept concerns smaller socially oriented questions (SOQ) that relate to the broader social issues. An example of an SOQ raised in this curriculum is whether school officials should cut funding for scoliosis screening in schools. It has been established that the heavy weights of backpacks carried by students tend to be especially burdensome on students diagnosed with idiopathic scoliosis. Idiopathic scoliosis is common among teenagers, with 1/5 students being diagnosed with mild cases less than 15 degree curvature in the spine. No further medical attention is needed beyond yearly visits to pediatricians in such mild cases. Although scoliosis is a common medical condition among teenagers, school officials are divided about whether or not to continue funding free scoliosis screening in public schools since so few serious cases are found. In serious cases the condition is easily curable when the individual is young, but untreated cases will require major intervention in adulthood to avoid crippling effects. Students learned more about the medical condition, its repercussions, and evaluated whether or not scoliosis could be classified as a medical condition of sufficient public concern so that funding for screening and treatment should be available based on criteria established by the public health officials of Massachusetts.

The third component of the curriculum included the lesson material that was related to the social issue. The lesson material included in this curriculum encompassed aspects of physics, physiology, health, mathematics, and statistics. Within the subject of physics, Newton's forces, vectors, force diagrams, and the addition/subtraction of forces by resolving along the x and y-axis were taught. These topics were used to answer the question of why it is better to carry a backpack on two shoulders rather than one, and why it is even better to carry your backpack on both shoulders and wear a hip belt.

Physiology was taught to help explain which muscles in the back were most at risk when incorrectly carrying the backpack or when carrying too much weight in the backpack.

Also explained where the five regions of the vertebral column and how the vertebral column and how posture was controlled by the muscles surrounding the spinal cord rather than the vertebral column, contrary to popular belief. The importance of evenly distributing the weight of the backpack, along with cutting back on the amount of books in the backpack was also emphasized to help maintain proper posture.

Health topics under discussion included the topic of scoliosis (see discussion above), nutrition, exercise, and the proper way to lift heavy objects. Nutrition, focusing on the importance of calcium and vitamin D, was studied to emphasize the importance of strong bones and how necessary they are when picking up heavy loads. Exercises necessary to strengthen back muscles, especially those that surround the vertebral column to provide better postural support, were also demonstrated and taught. Well-developed back muscles can significantly reduce the amount of back pain and postural problems experienced by students as a result of carrying heavy backpacks. Proper methods of lifting heavy objects can also reduce the number of injuries due to heavy backpacks, as it is the lifting motion that produces the sudden strain on back muscles.

However, an S-STS curriculum often seeks to intertwine supposedly unrelated topics. In our case a significant proportion of the unit concentrates on mathematical concepts related to data analysis and sampling along with a review of percentages which we feel are too often calculated in class and too seldom used to answer questions students care about. Students are asked to analyze data consisting of height and weight of students compared to the weight of their backpacks in percent terms, to see if the problem of excessive weights of backpacks is a problem in their community. Before analyzing the data, they review how the data were collected and the class decides whether proper sampling procedures were used to so as to produce a representative and random sample. The data are analyzed by finding percent backpack to body weight values, and these percentages are analyzed using graphs such that the concepts of mean, median, mode come up in the course of describing the distribution.

The last component of a curriculum developed in accordance with the Umbrella Concept consists of student's responses to the social issue. In the "backpack" curriculum, this took the form of group presentations. Students were broken down into groups of four and asked to present their results of the analysis of the data collected. Based on the results of the data, they were asked to propose solutions to the problem of the excessive weight of backpacks if they found that it was indeed a serious problem in the community. Students were also asked to design backpacks that would help distribute the weight loads carried by the students in a more even manner along the back, to reduce the risk of back injury.

The curriculum described above began to develop after consulting many resources, which included textbooks, journal articles, newspapers, and interviews with doctors. Several months were spent on lesson plan ideas, but the main difficulty encountered was presenting the information in an S-STS format. To help in presenting the material in such a way as to constantly intertwine the different school subjects described above, a unified method of organizing each lesson's objectives, themes, and activities was developed. Using a form similar to the one used by former WPI students, Jeffrey Modderno and Bob Tonning in 1995, the table below (Table 3.4.1) was established to serve as a template, which would help organize and develop the S-STS curriculum more effectively. The entire Backpack S-STS unit can be found in Appendix E.

Table 3.4.1

Lessons	Topics for Discussion	Lesson Plan/Material	Homework
Lesson 1	General Overview of the Backpack Project- What are the problems caused by heavy backpacks?	1.) Outline of Project- brief introduction 2.) Administration of Pre-Course Survey 3.) Administration of Pre-Course Evaluation 4.) Administration of Myers-Briggs Type Indicator	1.) Pre-course Survey 2.) Any other survey not completed in class
Lesson 2	What muscles are affected by my heavy backpack? What can I do to help prevent back problems due to my heavy backpack?	1.) Break students into groups of four 2.) Anatomy lesson on the muscles of the back and physiology lesson what these muscles do. 3.) Group activities studying back pain and correct ways to lift stuff. Please see lesson 2 for further details.	1.) Which muscles, if any, feel strained when you pick up your backpack the normal way? Do you still feel a strain when you pick up the backpack the "correct" way?
Lesson 3	How does the heavy weight of backpacks affect students with existing medical conditions pertaining to backs, such as scoliosis?	1.) Finish up lesson 2 by playing a "Quiz Game show Game" by dividing class into groups. 2.) Lesson on scoliosis- will include some anatomy, general information, articles passed out and broken up into groups for debate. Please see lesson 3 for further details.	1.) Prepare for debate the following class period. Includes trip to library to gather more information.
Lesson 4	Should scoliosis screening funding by cut back?	1.) Debate about scoliosis (about 20 minutes). 2.) Fact and Fiction (covers nutrition, osteoporosis) See lesson 4 for further details.	1.) Give questionnaires out to class, and tell them they have until lesson 7 to complete them)
Lesson 5	Why is carrying a backpack on two shoulders instead of one better for my back?	1.) Forces/vectors/free body diagram lesson. General introduction into Newton's second law and related applications to backpacks. Please see lesson 5 for further details.	1.) Draw a force diagram of the way you usually carry your backpack. If you were to use all the straps on your backpack, how does this force diagram change?

Lesson 6	How can diet help prevent backache and posture problems caused by my heavy backpack?	1.) Nutrition Lesson-covers bone health and necessary nutrients to achieve it, discusses how bones are formed. Have them calculate their daily calcium and vitamin D intakes individually, then analyze results for class. See lesson 6 for details.	1.) Continue to complete questionnaires.
Lesson 7	How can I test whether the heavy weight of backpacks a problem at my school?	1.) Bring data that students gathered along with questionnaire. Give students additional data. 2.) Lesson on experimental design and random sampling. See lesson 7 for details.	1.) What are some sampling biases that can occur with our sampling method? What are the pros/cons of this sampling method?
Lesson 8	Now that I have data, how can I organize and make sense of it?	1.) Lesson on analyzing data-percentages, graphs, mean, median, mode, normality of data.	1.) Prepare for backpack analysis presentations
Lesson 9	Is the heavy weights of backpacks a problem at my school?	1.) Presentation of findings. Groups should propose solutions to problem during presentations. 2.) Have students work on backpack designs.	1.) Group essay on the findings, including charts and graphs. How confident are you of your findings?
Lesson 10	What do my MBTI results mean?	1.) Guest speaker explaining about MBTI Results	1.) Prepare for backpack design presentations
Lesson 11	What type of backpack can maximize load distribution across the back?	1.) Presentation of project (+prizes and little "party")	1.) T.V. advertisement or infomercial on why your designed backpack is better/improved than traditional backpacks.
Lesson 12		1.) Post-course evaluation ("final") 2.) Post-course survey	

The following two sections of this report will look at two categories in the Backpack unit, Assignments and In-Class activities. Although both these categories are available in the unit itself, they will be expounded upon in the following sections.

3.5: In-Class Lessons & Activities

Lesson 1:
- Introduction on the Social Issue of the Curriculum
- Administer Pre-Questionnaire (found in Appendix F)
- Administer MBTI
- Administer Pre-Course Examination (found in Appendix G)

The curriculum begins with an overview of the problem concerning excessive weights of backpacks carried by students that has been recognized in the past few years. Students should gain a brief introduction about the serious, long-term health ramifications of carrying heavy loads over extended periods of times, which include back pain and posture problems. They should then be asked to hypothesize possible causes that have led to student's carrying more weight in their backpacks in the past few years. This type of hypothetical thinking is extremely important in the scientific community, as scientists are expected to formulate hypotheses both to predict and to explain their results.

Next, a pre-questionnaire (see Appendix F) should be administered to the students, so that "before and after" evaluations of the unit can be made. The questionnaire mostly asks students how they are presently enjoying their math, science and health classes (since they are taught in the traditional style). Questions include how often students learn new things in all these subjects, whether they think these aforementioned subjects they are learning have "real-world" applications, and how interested they are in the subjects they are studying. The intent of this questionnaire is to evaluate how well the traditional curriculum has cultivated students' desires and interests in the fields of mathematics and science, along with evaluating whether the traditional curriculum is being successfully applied, i.e. showing students the practical applications of these subject matters. A variation of the pre-course questionnaire is to be administered after the S-STS curriculum is taught, so it can be determined how well the S-STS curriculum unit has been received in terms of the same questions.

The MBTI will be administered next, so the distribution of "types" in the class can be determined (to gain a sense of whether the class is likely to be receptive to the S-STS approach). Past results have indicated that EF's (extraverted and feeling types) take to an S-STS curriculum particularly well. The MBTI administration usually takes 30-40 minutes, and its goal is to classify each student into a personality type or learning style.

The pre-course examination should be administered (see Appendix G) next so that another "before and after" type evaluation can be made. The examination is designed to evaluate the understanding students had about the information to be taught in the curriculum before the S-STS curriculum is taught. One does not want to take credit for teaching material already known to the students. A comparable evaluation will be administered after the S-STS curriculum is taught, to determine how much the students learned compared to where they were at the outset.

Lesson 2:

- Discussion on which back muscles are the most strained when carrying the heavy load of the backpack over extended periods. The vertebral column was also looked at, as was its role in posture and how posture is affected by carrying heavy backpacks incorrectly was explained.
- Students were asked to come to the front of the room and lift heavy objects. Students evaluated whether the student was picking up a heavy object correctly (if not what muscles would be injured) and evaluated what the correct method of picking up the object would be so the strongest back muscles would do the majority of the work.

Anatomy (the muscles of the back, the five sections of the vertebral column) will be studied in this lesson in an S-STS format. A heavy backpack should be kept at the front of the room (weight about 25 pounds), and students will be asked to put the backpack on their backs. They will then be asked to point to which muscles they felt burning or straining while carrying the pack, and these muscles should be named, and their origin, insertion, and function noted. Eight muscles in total should be identified in this manner (some which may not be felt, but should be stated at the end and shown on a muscle skeleton at the front of the room). The muscles that the class will learn about include lattismus dorsi, trapezius, teres major, teres minor, infraspinatus, eractor spinae, deltoid, and quadratus lumborum. Similarly, a student volunteer should be asked to stand tall with his/her back straight, so the primary and secondary humps of the vertebral column may be identified. In explaining the two humps present in the vertebral column, the five regions of the spine, cervical, thoracic, lumbar, sacrum, and coccyx, should also be discussed.

Involving students and constantly asking them questions presents the otherwise dry material of physiology in a more interactive and fun light. Rather than simply writing all the muscles on the board and having the students take notes, the material will be explained by interaction and hopefully make the names of muscles more identifiable to students.

In the same manner, the health topic taught during this lesson acts to constantly interact with the students in the attempt to avoid lecturing. The importance of lifting things correctly will be demonstrated to be relevant to students' everyday lives (and therefore more interesting), since lifting their backpacks is something they do every day. In addition, rather than segregating the two topics of health and physiology, the former topic seeks to include and incorporate what the students have just learned about muscles in the same lesson. Again, this emphasizes that all the subjects may be brought together and be relevant to students' every day lives, and that phenomenon can be explained not by one subject, but a combination of them.

Lesson 3: • Quiz Game Show was played by dividing the class into groups of four. The game show tested knowledge on muscles, the vertebral column, and the proper way to lift heavy objects.

• Discussion on why the heavy weight of backpacks places students who have scoliosis at special risk. Introduced debate topic of whether or not school scoliosis screening should be kept.

In order to "test" whether students have retained and understood the physiology and health material from the previous lesson, a quiz game show will be played by dividing the class in to groups. A series of questions will be asked to each group one by one. If the group is able to give the answer with no hints, they receive four points; with one hint, they receive three points; with two hints, they receive two points, and so on. If the group is still unable to answer the question after three hints, the next group in line is allowed to answer the question and earn two points. The group with the most number of points after 20 questions wins the game.

This activity allows teachers to both reinforce the material from the previous lesson and evaluate how much of the lesson students have retained without handing out the traditional pen and paper. This activity is designed to be revealing, entertaining and educational for the students and teachers alike.

After this activity, the topic of scoliosis should be introduced by tying the medical condition into the social concern of the heavy weight of backpacks. One manner in which this may be done is to note that students who have idiopathic scoliosis experience a greater degree of back pain due to their heavy backpacks and are at an even greater risk for developing permanent posture problems (since extreme cases of scoliosis, curvature of the spine, causes poor posture) due to the stress.

Contrary to belief, mild cases of idiopathic scoliosis are common amongst teens (due to the growth spurt), with one in every five teenagers having the medical condition. The frequency with which this medical condition occurs in teenagers brings it "closer to home", and thus more interesting to students. Various treatments for the condition should be gone over during this lesson, along with the deleterious outcomes that arise with the condition (see Appendix E for further details). Lastly, the class should be left with the debate question of whether school officials should cut funding for scoliosis screening in schools due to the costs associated with the screening process. The class should be divided into two groups, one against cutting funding, the other in favor of cutting funding, and these groups will debate this topic the next class.

Lesson 4:

- Debate on whether school screening for scoliosis should be continued. Compromise was made when students from both sides of the issue established ways to modify the current screening process to make it easier for students.
- Played a "fact-or-fiction" game, where students were divided up into groups and asked to determine if a variety of statements were fact or fiction. The statements pertained to nutrition and exercise topics that could help build stronger muscles and bones to prevent aches and posture problems that may develop due to heavy backpack weights.

While preparing for the debate, students should have learned and practiced a variety of skills, which include library research, organization, presentation, and public speaking. Students will have spent time in the library researching facts about scoliosis, statistics, and regulations on what makes a health condition a public concern so that state and federal funding may be obtained by a school system for preventative medicine. To gather this information, students will be at the library gathering journal and newspaper articles and searching the World Wide Web. After the students have obtained the data necessary to support their arguments, the two sides of the group will need to meet, prepare their arguments and organize their thoughts. This requires group work and cooperation, with students selecting a spokesperson and secretary amongst themselves. A debate format is competitive, but allows students not only to learn about scoliosis, but also to tie this medical condition (primarily a health/science topic) into politics and the backpack social concern as well, in an integrative educational context.

In class, one side of the issue will be allowed to make their arguments first via their spokesperson. The second side will be given five minutes to gather their thoughts on a rebuttal, and the second side's spokesperson should voice the arguments. Then, the second side will be able to present their arguments, and again the first side will be allowed five minutes to gather their arguments on a rebuttal. Finally, both sides will be allowed to make closing arguments.

Using the "fact-or-fiction" class exercise, students will learn information about nutrition and muscle building through a group activity rather than by lecturing. Students will be divided into groups, and handed a sheet of paper with a series of statements (see Appendix E for "Fact or Fiction" sheet). In groups, students will talk and discuss whether they feel these statements are "fact" or "fiction," and if they choose "fiction" they must explain why they feel the statement is false. The fact or fiction worksheet is strictly written as a series of facts about osteoporosis and nutrition, without any mention of backpacks. Rather, the backpack connection is made at the end of the exercise, while emphasizing how important nutrition is for strong bones which allow students to carry heavier loads in their backpacks without causing long-term back problems along with preventing future problems such as osteoporosis.

Lesson 5: • Have three backpacks filled with books at the front of the class. One backpack is designed to be carried on one shoulder, another designed to be carried on two shoulders with no other supporting straps, and the last designed to be carried on both shoulders with a supporting hip belt. Have all students come to the front of the room and try all three backpacks out, and decide which backpack felt the "lightest" (although all backpacks are filled with the same books, should be the backpack with the hip belt). This will be the start on the lesson of physics. Forces and force diagrams will be used to help explain why the backpack with the hip belt felt the lightest.

In the traditional curriculum, the topics of Newton's Laws, forces, and force diagrams are generally taught in the lecture format with very little interaction with the students. Most of the information is placed on the board, and students are seen busily taking down the information. The S-STS curriculum we designed seeks to step away from this approach, and uses physics to help explain a phenomenon which otherwise does not make sense. Why would a backpack that weighs the same as other backpacks seem lighter because it has a hip belt?

The answer becomes obvious when students learn about how the weight of their books and other items in their backpack act as forces which can be distributed across the back when using the hip belt and two straps on the shoulder. When students use only one strap, the force (weight), is concentrated in one area of the back, thus causing back pain and posture problems. During this lesson, students will also learn about how weight can be added if they are traveling in the same direction and subtracted if they are traveling in the opposite direction (since weight is a force, and a force is a vector quantity with both magnitude and direction).

Lesson 6: • Have students compile a list of all the foods eaten the day before. Let them break down the food into components (for example, pizza may be broken down into cheese, dough, tomato sauce) and determine how many vitamins they eat in a day and how many they should be eating in a day.

This nutrition lesson may be incorporated into the central backpack thematic of the lesson by stating that proper nutrition can make bones and muscles stronger, thus allowing more weight to be carried in backpacks without injuring muscles and causing posture problems. In order to make this lesson more interactive, students can be asked to write everything they ate the day before, and determine which vitamins they ate and which they didn't. Percent consumption of each vitamin type can also be determined, and compared to whether this fits what is recommended by the Food and Drug Administration.

Lesson 7: • Class discussion on possible sampling errors

Students will have already collected data from their peers if they are in middle school (if students are older, an explanation of how the existing middle school database was collected can be given) and now they will have an opportunity to voice some concerns over the manner in which this data was collected. Since what they will have conducted (or inherited) is a sampling study, many biases may have been incorporated into the database stemming from the sampling subset not representing the target population correctly. These biases may include not enough students responding to the questionnaires or a certain subset of the target population (such as a particular grade) responding more than others. Other errors that can occur is human error made while measuring weights and height along with machine errors (different scales may be "off"). By allowing students to discuss all the possible biases that may occur in the sample, they learn not to trust everything, and to always analyze things. After discussing everything that may go wrong, the discussion may be steered to how the sampling study may be conducted in the future to reduce certain biases.

Lesson 8: • Class discussion on percentages, ratios, and graphing (different types of graphs, independent/dependent variable).

This lesson will be devoted to teaching the mathematical skills necessary for analyzing the backpack data that the students will be gathering from their school communities. The mathematical topics that will be taught in this curriculum include percentages and ratios, mean, median, mode, graphing (bar, line, pie), and the difference between independent and dependent variables. Although it is difficult to have much group discussion during these mathematical lessons, care should be given in teaching these topics in the S-STS format and not reverting back to the traditional method.

In order to maintain the S-STS format while teaching the topics of percentages, graphing, mean, median, and mode should all be taught using backpack data gathered, received from other schools (Worcester East Middle School) or, if necessary, fictitious backpack data. The ideal variables to use while teaching these topics are backpack weight and student weight for teaching percentages, ratios, mean, median, and mode. Once these topics are covered, students should calculate percent backpack weight to body weight for the fictitious data or data from another school. They should then calculate the mean, median, and mode of the percentage data, and conclude whether the mean or median weight of backpacks is a problem for this data set (15-20% of their body weight is the maximum students should be carrying in their backpacks). Questions such as why the mean, median, and mode give different outcomes for the percent backpack weight to body weight for the data should be asked, and students should be able to answer which of these methods of calculating the average gives the most useful representation of the data.

The percent backpack weight to body weight calculated may then be used to teach student when and how to graph histograms and pie graphs. By adding the variable of whether students experience back pain, the concepts of independent and dependent variables may be taught (dependent variable would be whether students experience back pain and independent variable would be percent backpack weight to body weight).

After these topics are introduced, the TI-83 and computer program Microsoft Excel should be used to demonstrate how useful technology is in analyzing data. A rudimentary but complete set of instructions should be given to students on how to use the calculator and computer to analyze data, with calculators being distributed in class and using the computers in the library. Each student should enter in their own classes data (or "fake" data) themselves, and generate graphs and calculate percentages using this technology.

Lesson 9: • Group presentations on Analyzed Data

Students will have been divided into groups of four previously, and each group will have chosen up to three variables from the data set about backpacks in their community to analyze. These variables may include comparing carrying a backpack on one shoulder vs. two and back pain, length of time carrying the backpack and back pain, or percent weight of backpack compared to body weight and back pain to give three examples.

As homework, each group will have analyzed the variables they chose using percentages and graphs. Each group will then give a posterboard presentation explaining why they used the analysis they did on their variables and what they concluded based on their analysis.

This lesson exposes students to many different aspects of statistical reasoning. Essentially, students are given a set of data from which they must extrapolate results, thus allowing them to accumulate some knowledge about mathematics and apply it to solve a problem. Students must decide how to organize their data and analyze it, i.e. which graphs to use (pie, bar, line) and where/if to use percentages. In addition to this, students must also decide what their analysis tells them and what these results mean, thus forcing students to think about the broader "big picture." Not only will the students use mathematics, but they also experience an instance in which mathematics is used to explain things that can affect their everyday lives. Prior WPI studies have revealed that even the best students of Middle School age do not consider math an applied subject. Ironically, many of their classmates in less challenging academic programs to consider mathematics an applied subject in principle, but have never experienced it that way. When these students do experience mathematics in this light, they respond very well (LaChannell).

Another skill that this lesson teaches is about public speaking. The groups will be presenting their results to the entire class, thus providing an opportunity for students to practice this important skill. When students graduate, they will be presenting their findings in virtually any field that they choose to enter, thus, practicing ones presentation skills is of the utmost importance.

Lesson 10: • Guest speaker to explain MBTI results

A qualified MBTI user may be brought in as a guest speaker to explain the results of the MBTI examinations the students took in Lesson 1 of the curriculum. Although at one level the results can be explained by the regular teacher, the distributions of type in the general population, school and class for example, can be used to get at the Universe vs. sample distinction again. The validation or verification of the results requires a qualified user, since only they can give individual feedback and offer personality interpretations one on one. A guest lecturer may also be anticipated by the students who generally view guests in the classroom as a welcome change.

The guest speaker should run through each personality variable and what they signify, so that students fully understand what their results indicate. It will be ideal if this lesson is also taught in an interactive format, so that "lecturing" the students may be avoided. Some ideas that may involve interaction with the students during this lesson include having students write what personality type they *think* they are (after having been explained what each type signifies) and comparing what they write to what the indicator suggests they are. It should be noted that many students will not agree with the personality type assigned to them by the MBTI, and the presenter should work to reassure the student that the exam is not without error but that it has been carefully constructed. Another idea is to have students write, or discuss, what they feel each personality type division means and then explaining what they actually mean.

When the curriculum was taught at North High School, Professor John Wilkes from the Social Science department at Worcester Polytechnic Institute graciously agreed to be the guest lecturer to discuss MBTI results. Professor Wilkes actively engaged the students in discussion while explaining the results of the MBTI, and was wonderful at putting students to ease while the results were distributed. However, at 45 minutes it ran a bit long given the students' attention spans. A half an hour format should be planned even if it leans toward the lecture mode a bit. That is about as fast as a verification can be done for a group.

Lesson 11: • Group presentations on Backpack Design Projects

Students should be assigned in groups of four, and told to design their own backpacks that will function better at distributing the weights of books and other objects present in the backpack than the one's they typically use. Students should be asked to keep several other factors in mind apart from better distribution of weight while designing their backpacks, such as material to be used, aesthetic appeal, and cost of production. They will be told that their backpacks had to be efficient in distributing weights, while keeping in mind that students have to be willing to buy their backpacks (thus the backpacks have to be aesthetically appealing and affordable enough for the student population). How they assess their backpacks using force vectors is highly relevant to their grade.

Students will learn many skills during this project, the most evident of which is data gathering. In order to design better backpacks, they will have to assess the "competition's" new ideas, and see if they can improve on the prevailing design in terms of cost or functionality. Backpack design and materials used by manufacturers such as Jansport and L.L Bean are available online. One does not need to actually obtain various expensive backpacks, at least to gather some ideas for improvement. As important as finding which designs these manufacturers used is determining why they used the designs that they did, i.e. what their claims are. This may require some research work, but the advertisements will probably cover this, be they style, comfort, or capacity. In practice, one group got into tracking patents and several were looking through web sites to find the information on design alternatives.

In addition to research skills, students will also gain rudimentary experience with the field of marketing. They will learn often times making the best possible product, i.e. using expensive material and complex designs, does not necessarily make the product the best overall on the market. Cost is an important design consideration.

Once again, students will also learn how to present their ideas in a clear and concise manner, and further develop their public speaking skills as they present their results in front of class. The ability to convey your ideas to other people is of utmost importance regardless of the field one enters, and students have an opportunity to further practice this important art.

Lesson 12: • Administer Post-Course Examination (Appendix H)

- Administer Post-Course Evaluation (Appendix I)

There would be a final exam in any case, but this lesson has special features during the evaluation process. The post and pre course evaluations must mesh to some extent while on is trying to evaluate the unit. A key part of the evaluation is to see whether students learned any of the material taught within the S-STS curriculum and were able to apply this knowledge outside the realm of backpacks. Therefore, the examination is designed in the "traditional" format, with multiple choice, true-and-false, short answer, and one essay question (see Appendix H). The examination asks questions about information taught in the physiology, nutrition, health, physics, and mathematics lessons without referring to backpacks but involving some other applications. The post-course examination was designed to be more challenging than the pre-course examination, although the questions on both evaluations covered the same topics (the same topics covered in the Backpack Unit). The reason for this is because the pre-course evaluation was designed to assess whether the students had ever covered the material taught in the unit in other classes. Therefore, the questions on the pre-course were more general. The questions on the post-course evaluation were more in depth, since it was desired to evaluate how much information and the depth of information the students had retained.

The post-course evaluation survey (see Appendix I) is administered to determine whether the students enjoyed the integrated S-STS curriculum unit better than the traditional segments of the courses and compared to other science courses taken in the past. The evaluation may also be used to evaluate whether students' opinions on science and scientists have changed compared to those expressed during the pre-course evaluation due to the S-STS curriculum. It is anticipated that students will view science as a subject that is more relevant to their lives than they did before the unit (not something that was wholly disjointed and practiced by people in some remote laboratory somewhere). If they have come to view science and mathematics as subjects that have great interest and potential to direct their lives, this will be a great success, but with such a short exposure we will be pleased to find any evidence of a shift in the right direction.

3.6: Homework Assignments

Lesson 1: Essay Questions of Pre-Course Examination

Due to time constraints, may be necessary for students to complete the pre-course examination at their homes. Although this is not a desirable situation since all outside help on the examination is to be kept at a minimum, it may not be prevented since administration of the MBTI and pre-course evaluations will take so much time in class. Students should be told to answer the first 11 multiple choice questions in class, and take the remaining three essay questions home.

Although not ideal, this situation should not significantly alter the results of the pre-course examination. The essay questions on the examination are designed to be rather thought provoking, and are asked so that students may draw on a variety of sources along with intuition and common sense. The examination does not affect the grade, so the student's motivation and ability to "cheat" and look in books is minimized.

Lesson 2: At home, have students pick up their backpack as they normally do. Identify, if any, muscles that are pulled or strained during this task. Now, pick up backpack the "correct" way as was taught in class. Were any muscles strained or pulled?

This exercise allows students to combine the two topics in this lesson, muscles, correct exercises, and lifting techniques and tie these seemingly separate topics together with the overall backpack thematic. This activity allows students to understand how physiology and health can affect their everyday lives; they will be able to connect these two topics every day they go to pick up their backpacks. Rather than being names on a skeleton, muscles are "shown" on a living, three-dimensional object- themselves!

Lesson 3: Preparation for debate. Includes extensive research in the library along with group planning.

Students will be told in the classroom that heavy backpacks are especially deleterious to students with the common medical condition "idiopathic scoliosis." They will be told some of the problems this medical condition can cause, such as back ache, poor posture, and in extreme cases difficulty breathing (due to the excessive curve in the spine causing the ribs to brush against the lungs). In class, possible treatments for this condition will be given, and students will be told that school officials are debating whether they should cut funding for in school screening for the disease. Students should then be broken into two groups, with one group assigned to take a position supporting school officials in cutting back funding for screening and the other group to argue the reverse position against school officials. The two groups will then debate against one another during the next lesson.

Students will be instructed to gather data supporting their arguments, organize their arguments, and choose a spokesperson for each debate team. This activity encourages students to practice many skills, the foremost being library and web searches. Students will be searching the World Wide Web for newspaper or magazine articles related to the issue and along with government web sites to determine what characteristics establish whether a disease should have public funded screening.

Aside practicing web-searching skills, students will also learn how to communicate their ideas in a comprehensive and concise manner. They will learn how to organize their arguments and present them clearly, all the while working in groups. The ability to work well in groups is one that should be taught early to students since it is so important in the "real-world."

Lesson 4: Hand out questionnaires for data gathering to class.

Since data collection at the North High Community might take a while, students should be handed the questionnaires to be used for data collection before the experimental design lesson is taught. Students should be given at least seven questionnaires each and told to obtain data points from their high school and younger siblings (middle school) community. This will later allow students to evaluate whether or not their school district falls under the "at-risk" category in regards to the heavy weight of backpacks. The data collected will be analyzed by groups of students later in the curriculum.

Lesson 5: Draw a force diagram depicting the weight distribution of how you currently carry your backpack. Which, if any, muscles will be under the most pressure? Draw a force diagram depicting the weight distribution of how you should carry your backpack if you used all the straps on your bag.

This homework assignment seeks to connect the previously unrelated topics of physiology and physics, and show students how they are both used to affect their daily lives. Students will have learned how to draw force diagrams in class, and this homework assignment will allow them to practice their skill. In addition, this exercise will also allow students to visualize why they should use all the straps on their backpack, thus spreading social awareness.

Lesson 6: No homework assigned

Students will have time to continue gathering their data points from their classmates and siblings.

Lesson 7: Essay on possible sampling biases associated with the method in which the data was collected from their community.

Students will have learned about the many biases that can arise in a sampling study (a study in which a sample is drawn from a target population to draw conclusions about the target population) such as selection biases, nonresponse bias, and response bias. These errors are often a result of not being able to conduct a sampling study correctly, and these biases mostly involve in an inability of the sample to represent the "universe" or target population.

Since students will have conducted the sampling study themselves (via the questionnaires), they will be in a good position to evaluate some of the biases that may occur due to the sampling method used. This assignment allows them to really think about and analyze how they collected the data, along with applying a critical eye to the errors that may be represented in all data. A key component to science is the ability to be able to analyze ones own work along with the work of others, to avoid as many of the errors as possible and compensate for the rest in analysis. This skill is basic to science and practiced in the assignment outlined above.

Lesson 8: Prepare for presentation. Includes mathematical work, making a poster board, and group planning.

In class, students will have been divided into groups of three or four, and told to pick up to three variables they which to analyze from the data set collected. The analysis will involve calculating percentages and ratios, along with constructing various graphs such as histograms and line graphs (and thus being able to identify the independent and dependent variable). All of the material taught in the mathematics lessons during class will be used during this assignment to analyze the data set. Students will also be asked to extrapolate a conclusion from the data they analyzed, thus directing them to look at the results of their analysis (found by mathematics) and connect their findings to the backpack issue at hand.

Again, students will be asked to make a poster board and organize their ideas in a concise manner while interacting in a group. Group presentation skills will also be practiced as students will be asked to present their findings in front of the classroom.

Lesson 9: Group paper on results from data analysis presentations due

This assignment may seem redundant in light of the fact that students will have presented their results from the data analysis to the class already. However, some students communicate better in writing and we want everyone to have a chance to show themselves and their work at their best. Further, if students are unable to communicate their findings in a written manner (which is a very difficult skill to learn in the scientific field), then their findings are virtually worthless since no one else will learn about their results and be able to expand upon them. Science is a cumulative effort, with scientists building upon one another work, thereby making communication of results essential. This assignment seeks to enhance this skill.

Lesson 10: Prepare for backpack design presentation. Involves extensive library and web search, poster board presentation, and group planning.

Students will be asked to design their own backpacks to spread the load distribution across their backs. This will involve students determining what straps to put on their backpack and what material their backpack should be. In addition to "maximizing" load distribution, students will be asked to keep other constraints, especially cost considerations in their mind. Thus, it becomes a tradeoff problem. They should target a consumer group, in their case students such as themselves and those who buy things for them. Aesthetic considerations must also be kept while designing the backpack- if students like themselves consider the backpack "uncool" or awkward to use, they won't buy and or use the backpack properly.

Once again, research skills will be practiced during this assignment. Students should visit Jansport, Eastpack, and various other brand name backpack manufacturers' web sites while searching for ideas and critiquing them before coming up with their own designs. Other helpful sites include patent websites through which students can search to gain ideas on unique designs.

Students will also be able to exercise their artistic skills when they pictorially represent their backpack design on their poster board, in addition to presentation skills once again. This assignment allows students to practice the physics skills that they learned earlier in the curriculum.

Lesson 11: Group papers due on explanation of backpack design.

The reasoning behind this assignment is identical to that of Lesson 9's assignment.

Lesson 12: No homework assigned

3.7: Obtaining the Database for the Statistics Lesson

A significant component of the S-STS curriculum developed involved data interpretation and analysis using standard statistical methods on data obtained regarding percent weight of backpack to body weight and various other questions addressed by the backpack questionnaire (see Appendix A). For this reason, it was important to have a sound database that consisted of student's body weight, height, and backpack weight, and questions regarding how long the backpack was carried, how the backpack was carried, whether student's experienced any back pain due to the burden of their backpacks, and cultural views on pain.

The ideal age group that this data was to be collected from included students between 5th and 8th grade, as these students would not have reached their full height yet and were most at risk at having percents weight of backpack to body weight higher than recommended. In order to do this, data would need to be collected from late elementary school and junior high school students so that *high school* students could analyze the data. To further add to the complexity of the plan for the database, we wanted to collect the data from students in the suburb and in the city, to see if the excessive weight of backpacks was more prevalent in one of these two areas.

Constraints on teaching the curriculum at North High School, meant that such an extensive database could not be collected in time for the test run of the class. Therefore, the lesson was taught by having the students in the health class conduct their own survey sampling so that they could gain experience in data collection along with learning data interpretation skills. Each of the thirteen students in the class was handed seven copies of the questionnaire, with instructions to have their younger siblings, family friends, or their peers fill out the questionnaire while emphasizing that the target age group of the survey was 5th-8th graders (if possible).

Naturally, this was not the ideal method to collect data points and we expected that much of the data obtained was subject to sampling bias. The primary concern was that the data obtained did not come from the target audience as most of the students asked their peers for the information. Consequently, the database consisted primarily of 9th and 10th graders, students who were thought to be too old to be significantly affected by heavy backpack loads. The case could not even be made that the data collected represented a typical high school or specifically the North High School population, because the data mostly consisted of friends of students in the health class. Another problem with the data collected was that many of the questionnaires returned were incomplete, especially on question 26, which called for the weight of the student and their backpack, and the height of the student. A reason for this could be the lack of privacy in answering the question; although the questionnaire itself kept the student's identity unknown, their friends would be able to see the survey.

Nothing could be done regarding the North High School database, so we decided to collect another database if possible from the actual target audience for the next time the curriculum was taught. Proposal letters were sent out to Worcester, Shrewsbury, Nashoba, and Leominster public schools once again, this time requesting the help of junior high and middle schools (please see Appendix J for proposal).

Dr. Deidre Loughlin, head of curriculum and staff development for Worcester Public Schools, graciously responded to the proposal and facilitated contact with Worcester East Middle School. Worcester East Middle School, located on Grafton Street in Worcester, is the predominant source of students for North High School, so future North High School students taking this curriculum may be studying data collected from their own neighbors or siblings, thus making this social issue more personal, since most of them will have come from there.

Principal Kevin Keaney of Worcester East Middle School allowed data to be collected from one randomly selected class in each of four clusters at the school, thus generating approximately 120 data points. Math classes were used for data collection, and in exchange a mini, 2-3 day mathematics curriculum was designed at the behest of the principal. Initially, two math curriculum were designed, one in the S-STS framework (Appendix K) and the other in the traditional framework (Appendix L). Both curricula covered the same topics of mean, median, mode, percentages, graphing (histogram), and normality. The difference between the two curricula were that the S-STS curriculum taught these topics by only looking at the data collected on backpacks. In contrast, the traditional curriculum taught these topics by first instructing the students on the skills and the abstractions, i.e. how to calculate mean, median, mode, how to make graphs, and do percentages. After these lessons, students were assigned homework that asked them to compute mean, median, mode on a set of bogus data points consisting of basketball scores from fictitious basketball teams. The percentage assignment asked students to calculate the percentage from a series of fractions (a repetitious assignment meant to mimic assigning students problems 1-25 in their math book).

It was anticipated that two of the math courses could be taught the material in an S-STS manner, while the other two could learn the material in the traditional manner. At the end of the three-day curriculum, a quiz would be given to both classes to observe which ones retained and understood the material better. The quiz would include some questions that involved calculating

Principal Keaney appeared interested in the idea of administering two types of curriculum, however, when the idea was presented to the mathematics teachers in whose classrooms these curriculum would be presented, a substantial reduction in enthusiasm was observed at the thought that they might end up being a control class. The mathematics teachers appeared interested in the data collection aspect of the study by indicating that they would like to see the results of the study, and they insisted that they be allowed to teach the new and old material in any manner they wished. Hence, the study design broke down, but we got the data for future use, and a ringing endorsement of the S-STS way to teach math from the teachers.

Students in the four math classes that were sampled were distributed permission slips (Appendix M) to take home to their parents a week before the sampling was done. These permission slips were passive permission slips, meaning that if parents signed them they were exempting their children from the study. During sampling day, students were instructed to bring their backpacks filled with everything they had carried the night before.

The sampling was done Monday, November 6, 2000 during the 3/4th period (Lamberto classroom), 5th period (Sedares classroom), 7/8th period (Lynch classroom), and 9th period (Gianisso classroom). The mathematics classes in which the sampling was to be taken were selected "randomly" by the teachers based on which day would be most convenient for them. In each classroom, surveys were distributed and the children were asked to complete the backpack questionnaires (Appendix A) while five students at a time were taken to the nurse's office where their weight, height, and weight of backpack were measured and recorded.

The data gathered was compiled and analyzed, and a copy of the results was given to Worcester East Middle School so that students could learn the outcome of the study in any fashion the teachers wanted to present it as part of our mini-curriculum.

Chapter Four: Results

4.1: Lesson Comments and Suggested Improvements

Lesson 1: General Overview of the Backpack Project

This introductory lesson took one day to complete due to time restraints that restricted the S-STS curriculum to be taught in four weeks (with three classes each week). Since there were many forms to be fill out (MBTI, pre-course evaluations, and pre-course examinations) and a general overview about the project to be given to the students, the forms were filled out in a rush and some forms needed to be taken home. Since students were not allowed to take the MBTI home, they were told to finish the essay questions on the pre-course examinations (since it was less likely students could look up the answers to these questions in a textbook) and the pre-course evaluations for homework.

Understandably, this was not the ideal manner in which these questionnaires should be administered, since no outside help of any kind should be used on the pre-course examinations, and by allowing students to take these examinations home this variable could not be fully controlled for. Although it was not as critical that the pre-course evaluations be completed in the school as it was that other things not go home, it would have been preferable to have administered it in class so that any questions the students had could be answered by the teacher (that way all the students would interpret the questions in the same manner).

Traditionally, questionnaires are read by each individual student, and then filled out by him or her at one's own pace. However, many students had problems with the vocabulary of the MBTI (found it difficult) and some general questions regarding the pre-course examinations and evaluations were also hard for them. It would have been more helpful to administer the questionnaires orally, with the teacher reading through the questionnaires one item at a time and another student teacher/aid available to resolve any problems that an individual student might have in the process. Although administering the questionnaires orally would take more time, it would hopefully be "time well spent", as the students' questions during the activity are anticipated to be fewer, while their comprehension of what the surveys are asking is anticipated to be much higher. Ninth graders are the youngest people for whom the MBTI is considered appropriate, and administration guidelines suggest having people skip items rather than having them interpreted by someone else and having people respond to unfamiliar cues. For the 6th to 8th graders, the 3rd to 8th grade personality type indicator MMTIC (Murphy-Meisgier Type Indicator for Children) will have to be used.

After the questionnaires were completed, the rest of the class period was devoted to giving a brief summary about the problems that can arise from carrying heavy backpacks over extended periods of time. From the onset of the unit, an effective teaching style which relied completely on student participation was sought and hopefully applied. The information contained in this and subsequent lessons was not stated to the students outright. We tried to pose questions that would inevitably led the class to the desired answers in a Socratic dialog. This process challenged both outgoing and quiet students alike to be alert at all times, knowing there was a possibility of being called on.

In keeping with this approach, questions to provoke dialogue that had no right or wrong answers were asked in class, such as "Have you ever experienced back pain?" or "Do you feel your backpack is too heavy to carry comfortably?" Such questions "loosened" the students up, and served as a confidence booster to the more shy students, since the questions posed could be answered by anybody.

Lesson 2: The muscles affected by carrying heavy backpacks

In this lesson our goal was to present the rather dull information of muscle names, their insertion and function, in an interactive manner. Students were asked to come to the front of the room and pick up a heavy backpack, and point out which of their muscles were strained with this activity. This allowed students to get a more three-dimensional idea about where different muscles in the back are located, something that is not possible by looking a picture of the muscle. Student were also able to directly correlate learning the rather long and difficult Latin names assigned to these muscles to actual entities that affected their lives. The lattisums dorsi was not just another word to remember, but rather the muscle that hurt when a heavy backpack was lifted on one shoulder.

Although this activity was useful in depicting the four major muscles of the back (lattismus dorsi, trapezius, teres major and minor), it was harder for students to point out other relevant muscles of the back. This was because these muscles were located *beneath* the major muscles already depicted. Therefore, some of the muscles had be verbally explained and visually shown using two-dimensional depictions, which lost some of the impact we were striving to introduce during this lesson. It would have been helpful to have a three-dimensional model, such as those found in many college anatomy classes, to point out these "hidden" muscles so that students would be able to visualize where these muscles were and how they were important more clearly.

The homework assigned for this lesson is designed to further integrate the backpack and physiology connection, while demonstrating the impact of carrying a backpack on one shoulder rather than two on muscles. Although students will not be able to answer why it doesn't strain their muscles to carry a backpack on two shoulders rather than one, it will allow them to identify this problem and identify the muscles that are in danger due to this behavior. Although the activity should not take long, it is a valuable way to introduce the backpack problem.

Lesson 3: Game Show and Scoliosis Information

The first part of this lesson was devoted to reviewing the material from the previous lesson and ensuring that students had indeed retained and learned the information that was discussed. However, rather than simply give the students a test, as would be expected in a traditional curriculum, we sought to involve the students in a more fun and interactive manner while still obtaining the information we wanted to know. The students really enjoyed this component of the lesson as it gave them an opportunity to compete, in a friendly manner, with their classmates. This pushed students go home and do the homework that was assigned for this lesson, and really practice and look over the names of the muscles.

The game show turned out to be a success, partly because we found that students had learned a majority of the muscles. It was observed that more students remembered those muscles that were on the surface, since during the previous lesson they were able to identify those muscles on their own body. The smaller muscles of the back, which were hidden below other larger muscles were harder for students to remember.

The second part of this lesson brought up the health topic of scoliosis by making the case that students with scoliosis (which is a relatively common condition in adolescents) may have their condition worsened or experience extreme back pain due to heavy backpack weights. This part of the lesson was difficult to present in an interactive fashion, so approximately fifteen minutes of this lesson was given in a rather "traditional" manner with some lecturing. Although this method was effective in communicating a larger amount of information to the students in a shorter amount of time, it did not seem to hold the students' attention for very long. Future teachers should emphasize the debate topic, which revolves around the issue of cutting school funding for scoliosis screening rather than focusing on the more technical information regarding scoliosis. Students should encounter the technical aspects of the disease while researching for information in support for their side of the social debate.

Lesson 4: Scoliosis Debate and Fact or Fiction

The scoliosis debate went well in class, and it was evident that students had researched their positions to the best of their ability using the resources available to them. During the debate, students quoted articles from the *Journal of the American Medical Association* to support their respective sides. These articles were found on the world wide web, and largely dealt with studies that had been conducted on the benefits and disadvantages of scoliosis screening in various school systems throughout the United States of America (see Appendix E for one such article).

However, in the class of 13 students, one student had recently undergone surgery for scoliosis, and two others had lesser degrees of scoliosis, which had not needed any intervention yet. Therefore, the class as a whole was largely biased in favor of school screening, and the debate reflected this bias. In the future, it is recommended that the teacher spend time in class discussing possible pros and cons of scoliosis school screening, with each side of the debate being given equal time. Although this method detracts from the amount of research students will do on their own for the debate, it might prevent the debate from become one-sided as it did in the North High School health classroom.

The Fact-or-Fiction component of this lesson also went very well, and students appeared to enjoy discussing the "true or false" statements amongst themselves. As seen in the Appendix, these statements are written so that not many students will immediately know the right answer, but rather there must be a thought process and discussion required to arrive at an answer. Judging from the explanations given by students as to why certain questions are right or wrong, the statements succeeded in this venue.

Lesson 5: Explaining heavy weights by physics

This lesson was difficult for students to understand, mainly due to the complicated nature of expressing weight as force vectors. Having the heavy backpacks and asking students to pick them up on one shoulder, two shoulders, and two shoulders while using the hipbelt helped students to relate the distribution of forces across the back better. However, the concepts of forces as vector quantities having direction and magnitude was harder for them to comprehend, along with the concept of normal force. More time should be spent on this material. It is likely to be needed, even if only the basics of this lesson should be taught. Students should know enough about the subject so that they can understand how the weight can be spread across the back when wearing the backpack on two shoulders rather than having the weight concentrated on one shoulder. Beyond this, the material becomes too complicated and can be treated better in a physics class after this introduction to the concepts.

Lesson 6: Nutrition

Our students enjoyed this lesson mainly because they were able to relate dietary recommendations to their own food consumption. Jackie Letino had already covered nutrition earlier in the year, and students were familiar were charts and tables depicting daily allowance.

This was the first time that students could apply these charts and graphs to their own lives and how much they ate, and this lesson helped reinforce what Jackie had taught earlier while extending the sense that lifestyle choices affect the risk of being afflicted by back problems.

Lesson 7: Sampling Error

This lesson went very well, mainly because there was no "right" answer so all of the students in the class felt comfortable bringing up ideas during the class discussion. This lesson was more creative than other lessons such as the physics or math ones. Students arrived at many creative ideas regarding possible was in which the data that was collected at North High could be biased. Some of these were good openings for us to describe the different types of biases (response, nonresponse, etc.) that can arise in a sampling study. Later, students brainstormed about possible ways these biases could be avoided for future data collection.

Lesson 8 : Math Lesson

The first part of this lesson (which involved teaching students how to analyze data by hand using graphs, percentages, mean, median, and mode) went very well. Some of the material, such as percentages and graphing was familiar to the ninth and tenth graders, so this lesson helped reinforce what they already knew and they could apply these concepts to "real-life" data that was relevant to them.

The next part of the lesson demonstrated how technology, such as statistical calculators (TI-83) and computers can be used to help analyze data using the same concepts of graphs, percentages, etc. that were done by hand. Calculators were distributed to the thirteen members of the class, and students were taught how to use these machines to analyze the "fake" data. Although students were taken through the process stepwise, the majority of the class did not understand how to use or appreciate this technology. It was expected that students would see how much time and effort could be saved using calculators, but this was not the case and students maintained their stance that these machines were "confusing" and "too complicated" to analyze this relatively small and simple database. In the future, this part of the lesson should be taught very slowly (it was a bit rushed when we were teaching since we were on a deadline) and a written set of instructions might be useful so students won't have to rely on memory of which buttons to press to analyze the results.

Teaching the students how to use Microsoft Excel on computers to analyze the data was also difficult since the school's library only had two computers that were readily accessible. Therefore, much of the lesson had students crowded around a computer while one person actually moved the mouse and analyzed the data. This could be why many of the students did not take a keen interest during this part of the lesson. In the future, the computer lab at the school should be booked, so that each student has a computer on which they are working while the instructions are being given. If the school does not have enough computers, the class should be divided so that half the class is learning how to use the calculator while the other half is learning how to use the computer.

Lesson 9 : Group Presentation on Analyzed Data

This lesson was very effective in analyzing the large amount of information gathered by the backpack questionnaires in a relatively short amount of time. Each group analyzed two different variables, thus allowing the analysis of many more variables at a given time.

All of the groups used tables and graphs (largely bar and pie graphs) to visually represent their results, as was emphasized by the math lesson in the curriculum. However, it was apparent that the calculator section of the math lesson was not very well understood by the students, since none of the groups opted to use this technology in helping them analyze the data. The graphs that the students generated where either drawn by hand (three out of the four groups did this) or made on the computer using Microsoft Excel. All of the groups also used percentages when appropriate and together arrived at the conclusion that back pain and the heavy weight of backpacks is not a problem at North High School.

From observing the class, it is apparent that more care has to be given on utilizing technology (such as calculators and computers) to help analyze the everyday data in this curriculum. The majority of students in class had never used a TI-83 calculator or Microsoft Excel to make graphs or find percents before and one way to ease into this technology better is to have students gain access to computers and calculators while the lesson is being taught. We had not expected to be introducing these concepts and devices, but it had to start somewhere. Hence, we are committed to the statistics lessons and have backed them up by developing a serious middle school student database that can be given to the students as an Excel spreadsheet. First, students should learn to calculate the percentages, draw graphs, and find the mean, median, and mode by hand themselves (using the data generated from Worcester East Middle School or a "fake" data set). Then, the teacher should give a step-by-step account of how to analyze these results using the calculator and computer (with students following on their calculator or computers). To reinforce what the students have learned, they should be broken into groups and given small data sets to analyze in class.

Apart from learning math, it was apparent that students had improved and felt more comfortable speaking in front of their classmates. During the presentations, groups had much more eye contact with the audience compared to during the debate and class discussions. In addition, we had two relatively shy students in the class asking many questions and representing their respective groups in the presentation.

Lesson 10 : Guest Speaker for MBTI Results

As predicted, the guest speaker was a welcome change to the students. Professor Wilkes of Worcester Polytechnic Institute, an "expert" in the Myers Briggs Type Indicator was able to answer all of the students' questions, verify the results, and put them at ease. People sometimes become upset when they receive their results for the MBTI, because they feel the test was not accurate or is limited in some way, and an experienced individual is needed at this time to help put things in perspective.

Professor Wilkes did a good job keeping the students interested and somewhat involved while discussing the MBTI results, though the lesson was being given partly in the traditional lecture format with overhead slides. In the future, guest speakers should be carefully selected so that a level of interaction is continued that involves the students in a process of questioning the results and considering their meaning.

An entire period (approximately 45 minutes) was devoted to distributing MBTI results for 12 students during this lesson. This was more time than was necessary for this lesson, and consequently the students' attention began to wander during the latter part of the period, after 30 minutes. In the future, teachers should take into consideration how many students they have in the class and plan this lesson accordingly. The remainder of class time can be spent giving students time to work on their presentations for the next lesson.

Lesson 11 : Backpack Design Presentation

Students appeared to enjoy this lesson a lot, mainly because it allowed them to showcase their artistic capabilities while utilizing research skills and their knowledge of physics (learned in Lesson 5). The backpacks the students designed were creative (with different colors and designs) and practical (in terms of the material and costs of the backpack).

Although students did not have a problem arriving at original ideas in terms of the aesthetics of the backpack they were designing, many of their ideas for the design were variations on designs offered by companies such as Jansport and L.L. Bean. This was to be expected, since students would not have the ability to design a breakthrough backpack that was better for the back than anything on the market in less than a week. This class would have worked as well had they compared existing design systems and rated them relative to one another. It was heartening to see that students were able to support (using information they learned during the unit) their claims as to why certain "devices" (such as hipbelts or wheels) were to be put on their backpacks. Students were able to take ideas from different companies and merge them to make better backpacks. The amount of research that students did for their backpack design projects was evident during their presentations, although many students mentioned they wished they had more time to devote to the research.

It was also evident that students were becoming much more comfortable speaking in front of the class and voicing their opinions. During Lesson 1, we had very few students raise their hands and volunteer answers, and even during the scoliosis debate, it took about fifteen minutes before the students started to feel comfortable enough to speak out loud. However, from the onset of this lesson, each group was eager to present, and this time it was the students who were asking questions at the end of each presentation rather than just the teachers.

Lesson 12 : Administration of Post-Course Examination and Evaluation

This lesson was similar to Lesson 1, since the class period consisted of filling out a form and taking exams. Administration of the post-course evaluation was done first, so that students could spend the rest of the time working on the post-course examinations. Students preferred the brevity of the post-course evaluation to the pre-course evaluation, and took about fifteen minutes to complete the survey. Future groups are advised to shorten the length of the pre-course evaluation if possible, so that students do not lose interest while filling out the form.

After becoming accustomed to the S-STS style of teaching, students did not appreciate the post-course examination as much. We had downplayed exams in favor of participatory activities and assessed them without giving written examinations, but rather evaluating knowledge through discussion (such as the game show) and projects (backpack design and data analysis). After four weeks, to come back to traditional test taking disappointed many students, but nevertheless student performance on this examination was markedly better than that on the pre-course examination, so their was a documented gain associated with the unit.

The post-course examination was purposely formatted in the "traditional" manner (so that backpacks were not mentioned, and questions were mainly given as true-false and multiple choice). The reason why this was done was to see if students were able to apply the knowledge they learned about mathematics, health, and biology in the context of the backpacks issue to questions that did not deal with backpacks. Obviously, if students were not able to apply the information they learned to other contexts, the S-STS style was not very effective. In fact, that is one of the existing critiques of socially contexted science education in the literature, so we felt that we needed to see how serious a problem this really is.

Future groups who use this unit might consider changing the post-course examination to another group game show (like the Quiz Game Show used for testing muscle/bone knowledge in unit) or individual game show (in the *Jeopardy* or Who Wants to be a Millionaire format). This way, students will not feel as if they are being “tested”, but teachers can simultaneously observe how much information students retained and were able to apply. Of course, if they want to do that at the end they must do it at the outset as well.

4.2: North High Pre and Post Course Examination

The relative success of the backpack unit was measured using three methods, student teacher observance of the class, the pre and post course examinations, and the pre and post course evaluations. As mentioned, the pre and post course examinations were administered on the first and last day of the unit respectively, and were used to evaluate whether or not the students learned any information from the unit. The pre course examination was constructed to be easier than the post course examination because the former was intended to gain an understanding of the students' knowledge level on certain subjects before the unit being taught. This prevented us from taking credit for information that students already knew prior to the unit. In contrast, the post course examination was designed to be more difficult than the pre course, because it was expected that students would have learned from the unit and would thus be able to answer more in depth questions about the topics. The questions on both the pre and post course examinations were mostly asked in the "traditional" method, as multiple choice, truce-and-false, short answer, and some open ended questions. For a complete copy of the pre course and post course examinations please see Appendices _ and _ respectively.

The pre and post course examinations were significant and interesting because the students posted a strong increase in their knowledge. While the topics and items were not all the same in the pre and post course evaluations, all of the overlapping topics saw an increase in the students' scores. Table 4.2.1 and 4.2.2 on the next page give a list of topics that were tested on both the pre course examination and post course examination respectively, and the average score of the class for each topic. The score for each question was out of 100, and the average scores on each topic for a total of 11 students were tallied. The topics that are bolded in tables 4.2.1 and 4.2.2 were asked on both the pre and post course evaluations. A direct comparison of these topics is displayed in Table 4.2.3 on the next page. Also given in Table 4.2.3 is the percent increase from the pre course to the post course examinations for all topics that were similar in the pre and post course exams.

Table 4.2.1

Pre-test

Topics	Score
scoliosis	41.82
vitamins	63.64
osteoporosis	54.55
vertebrae	54.55
muscles	54.55
hypothesis	81.82
experimental design	0
forces	63.64
vector	45.45
outlier	18.18
percentages	54.55
incorrect exercises	42.73
data	9.09
vitamins & nutrition	18.18

Table 4.2.2

Post Test

Topics	Score
vertebrae	74.55
muscles	80.91
scoliosis	100
scoliosis treatment	54.55
scoliosis debate	50
forces	79.09
osteoporosis	60
vitamins	81.82
vitamins	100
exercises to avoid	50.91
data	60.91

Table 4.2.3

Category	Pre	Final	Percentage Increase
Data	9.09	60.91	85.07
Vertebrae	54.55	74.55	26.83
Muscles	54.55	80.91	32.58
Vitamins	63.64	81.82	22.22
Osteoporosis	54.55	60	9.09
Vitamins (2)	18.18	100	81.82
Forces	63.64	79.09	19.54
Scoliosis	41.82	100	58.18

Figure 4.2.1 on the next page graphically depicts the comparison between topics seen in Table 4.2.3 above. The maroon bars indicate the percent score on the post course examination and the blue bars indicate the percent score on the pre course examination for the topics that overlap on the two exams. As seen, students did remarkably better on analyzing data and

vitamins on the post course exam compared to the pre course, indicating they had learned a great deal on these two topics. Figure 4.2.2 below shows the percentage increase in score for certain topics between the pre course and post course examination, again emphasizing that students learned a great deal during the unit.

Figure 4.2.1

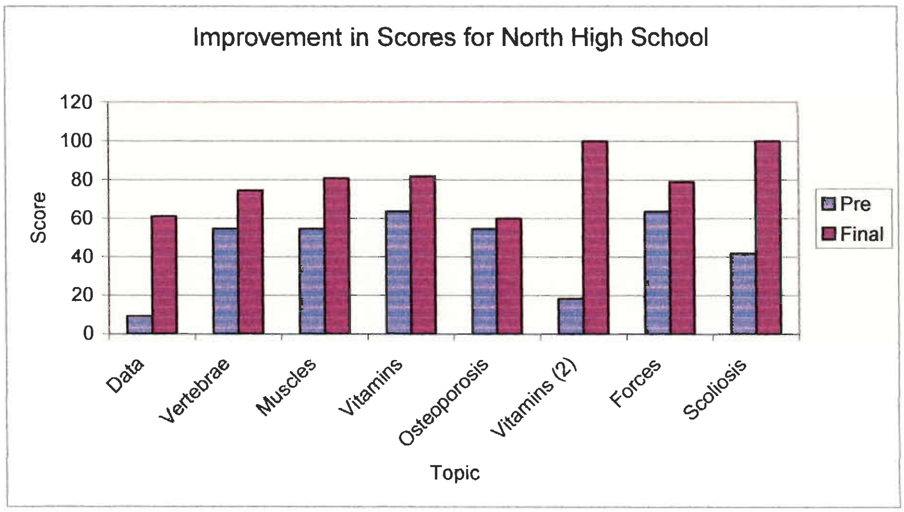
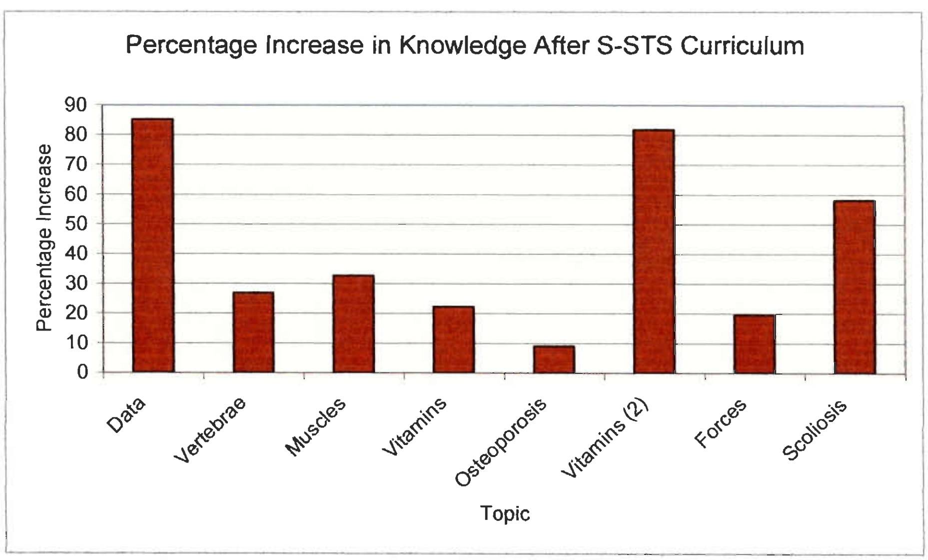


Figure 4.2.2



Overall, the average on the pre test was 41.82% while the average on the post test was 70.10%. On the pre test one student passed (score of 83.33%) and the next highest score was a 57.78%. On the final 8 of the 11 students passed (1 A, 2 B's, 3 C's, and 2 D's).

Before the course, two of the eleven students had an extensive knowledge of scoliosis. They were able to identify what scoliosis was and supply additional information. Three students had partial knowledge of scoliosis. They could identify the multiple-choice definition of scoliosis and they supplied incomplete or incorrect additional information. There was one student who just answered the multiple-choice question correctly. By the end of the course, all of the students knew what scoliosis was.

The students' knowledge of muscles and vertebrae increased a great deal by the end of the course. On the pre test, the students were only asked a multiple-choice question of the different regions of the vertebrae. On the final examination, the students were expected to be able to label the regions and give a characteristic of each region. Even with the increase in difficulty of the questions, the students' scores on matters of the post test items increased as compared to their being able to handle these subjects at the outset—as seen in Chart 3. A similar jump was evident in the knowledge of back muscles. In the pre test, the students were asked (in a multiple-choice question) to pick out the muscle that was located in the back. By the end of the course, the students were able to identify three muscles in the back, give their origin and/or insertion and/or function

The students also gained a more extensive knowledge of forces. Before the course, a multiple-choice question was asked about what were and were not forces. Students were also asked to identify a vector quantity when given five choices. After the course, students were asked to answer a short essay question asking: "in terms of force diagrams, why is it better to wear your backpack on two shoulders rather than one shoulder?" and could not do it. Three students were able to give only a partial answer and two students were unable to give a correct answer. The average number of points earned, out of ten, was about eight.

The students learned a great deal about numeric data manipulation and presentation over the course of the four-week curriculum. They were not too thrilled about this. Prior to the course students were asked what an "outlier" was, to do a basic percentage problem, and to graph a set of data points. Most had a lot of trouble, and that concerned us, so we focused on that kind of issue. By the end of the course, the students were able to identify the dependent and independent variables of a data set and were able to analyze the data in a method they thought was appropriate. The average grade for their effort was 61%. Only two students were unable to answer any of the data oriented questions while four students were able to earn full credit.

Among some other topics, there was a slight gain in knowledge. As seen in chart three there was a slight increase from pre to post course when students were asked to identify the group that was the least likely to be affected by osteoporosis, whether osteoporosis could be prevented, and to give a way to prevent this disease. Pre and post course the students were asked to identify the two most essential vitamin/minerals for healthy bones and the proportion that could do this jumped from 20% to 100%. In addition, nine of the students were able to adequately able to answer the difficult question of whether from October to March the sunlight is too weak to allow the skin to produce any Vitamin D.

As can be seen from this analysis, the students at North High School appeared to learn a substantial amount of information from the Backpack unit. Even an increase of 20 to 30 percent in score is substantial, because the post course's exam questions were more difficult than those of the pre course. It should be noted that the pre course examination did not affect the students' grades, while the pre course examination did. Therefore, it is possible that students put in more effort for the post course examination compared to the pre course examination.

4.3: North High Backpack Survey

As previously mentioned in Chapter 3, a substantial portion of the Backpack Unit revolved around analyzing a database that was generated from a backpack survey (please see Appendix A). The backpack survey was designed to be distributed to 5th to 8th grade students and asked questions such as: do you carry a backpack? how often do you carry a backpack? do you carry your backpack on two shoulders or one? have you ever experienced backache due to your backpack?, etc. The survey also asked for the student to take their own weight, height, and the weight of the backpack they were carrying the day they took the survey. Students would then analyze this database using mean, median, mode, percentages, ratios, and graphing (all taught in the unit using the graphing calculator and Excel spreadsheet).

When the Backpack Unit was field tested at North High School, a database had not yet been collected for the students in the health class to analyze. Therefore, the eleven students at North High School were told to distribute copies of the survey to their younger brother or sisters, neighbors, or friends in order to generate the database. However, the database that was returned consisted of largely 9th and 10th grade students, and the information on most of the surveys was largely incomplete. Nevertheless, students could still analyze some of the variables from the database, although the situation was not ideal. The results of the analysis are presented here.

Procedurally, correlation matrices were run first on the data to identify relationships in terms of item pairs. Then the interesting and significant relationships were extracted and put into cross tabulations to clarify the nature and degree of the correlations. Some of the correlation coefficients were the opposite of what we predicted. There were also many responses to questions that turned out not to be related that we had expected to be related. Table 4.3.1 below gives some of the interesting and significant relationships obtained from the correlation matrices generated using the SPSS Software program. All correlations have a $p \leq .05$ and the database generated contained a sample size of less than 70 surveys. For a complete copy of the questions listed in Table 4.3.1, please see Appendix A.

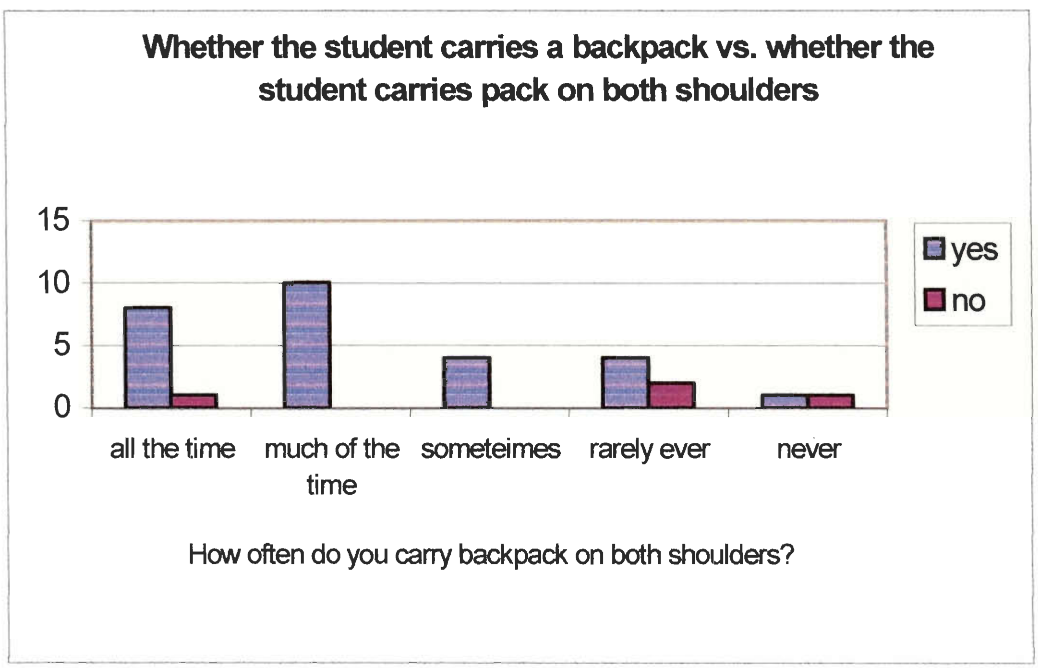
Table 4.3.1
Significant Pearson Correlations (less than .05 with a sample size of under 70)

	Your backpack is too heavy…etc. :	If you have experienced pain, rate the severity	If two shoulders, how often do you carry it on two shoulders?	How long do you carry your backpack?	Carry pack anyplace besides school?	If pain, was pain caused by pack?
Grade (4th to 10th)	--	-.465	--	--	--	--
Carry pack? (yes or no)	.345	--	.329	--	--	--
How do you get home? (walk, ride the bus, ride from family/friend, or a combination)	--	--	--	.433	-.515	-.433
Your backpack is: (too heavy to be carried comfortably most of the time to not a problem to carry	--	--	--	.372	--	--

Among the more interesting findings, there was no correlation between the size of the largest books carried and to whether the students thought their backpack loads caused the back pains they reported. It was expected that the heavier the books, the more likely a student was to think their back pain is caused by the load in their pack. There was a relation between weight of the heaviest book and whether the student experienced back pain, but there was no positive or negative correlation to whether the student thought their pain was caused by the backpack.

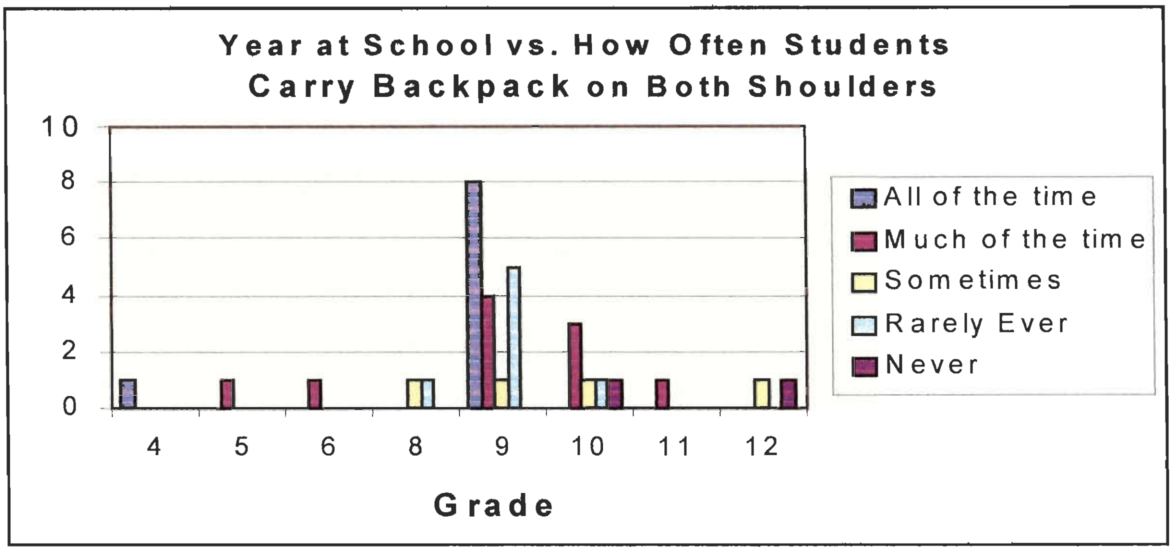
When the question "do you carry a backpack" was compared to "do you carry your backpack on both shoulders", an interesting finding was found (please see Figure 4.3.1). As seen from the figure, of the approximately 32 responses for these two questions, the majority of the students (87.5%) carried a backpack, and 60% of the students who carried a backpack answered that they carry the backpack on both shoulders, "all the time" or "much of time". It was expected that students who do carry a backpack would not carry it on both shoulders because it was not "cool" to do so, but clearly, this was not the case.

Figure 4.3.1



The findings above were supported by comparing the "which grade are you in" vs. "how often do you carry your backpack on both shoulders" (please see Figure 4.3.2). As seen from the figure, of the 32 people who answered both these questions, 24 of them (75%) were 9th or 10th grade students (too old for the database that was in mind). When looking at the data for the 9th and 10th graders, it can be seen that the majority of the 9th grade students (66.7%) carry their backpacks on both shoulders "all the time" or "most of the time" and 50% of the 10th grade students carry their backpack on both shoulders "most of the time".

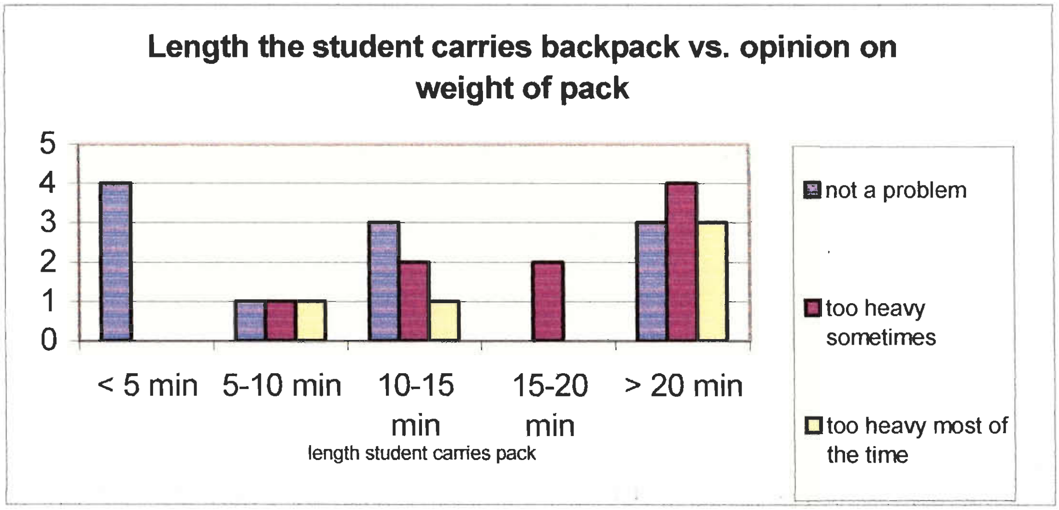
Figure 4.3.2



Another interesting comparison can be observed when comparing the length of time a student carries this/her backpack vs. their opinion on the weight of their backpack as seen in Figure 4.3.3 below. Of the 25 students who answered both these questions on the survey, 72% (18 students) carried their backpacks for 10 minutes or longer on their backpacks. Of these 18 students, 66.7% of them (12 students) felt that their backpack was "too heavy sometimes" or "too heavy most of the time," thus indicating that these students might exceed the 15% to 20% body weight limit on their backpacks that is recommended by physicians.

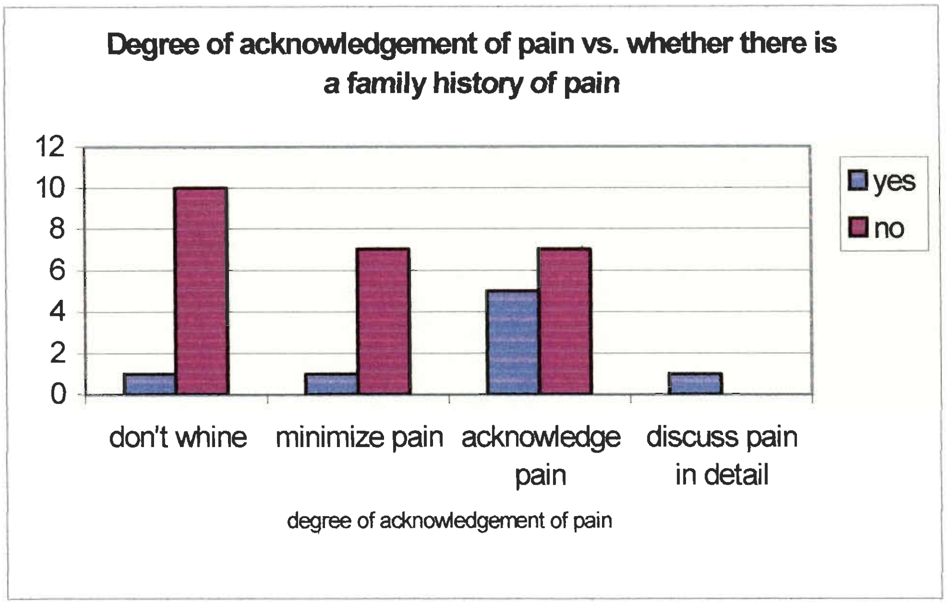
In contrast, the 7 students who carried their backpacks for less than 10 minutes, 71.4% of them (5 students), felt that their backpack was not a problem (most probably because they did not have to carry it for extended periods of time). It should be kept in mind that these students might have exceeded the 15-20% body weight recommendation set by physicians, but since they did not carry their backpack for long periods of time, heavy backpacks weren't a large problem for them.

Figure 4.3.3



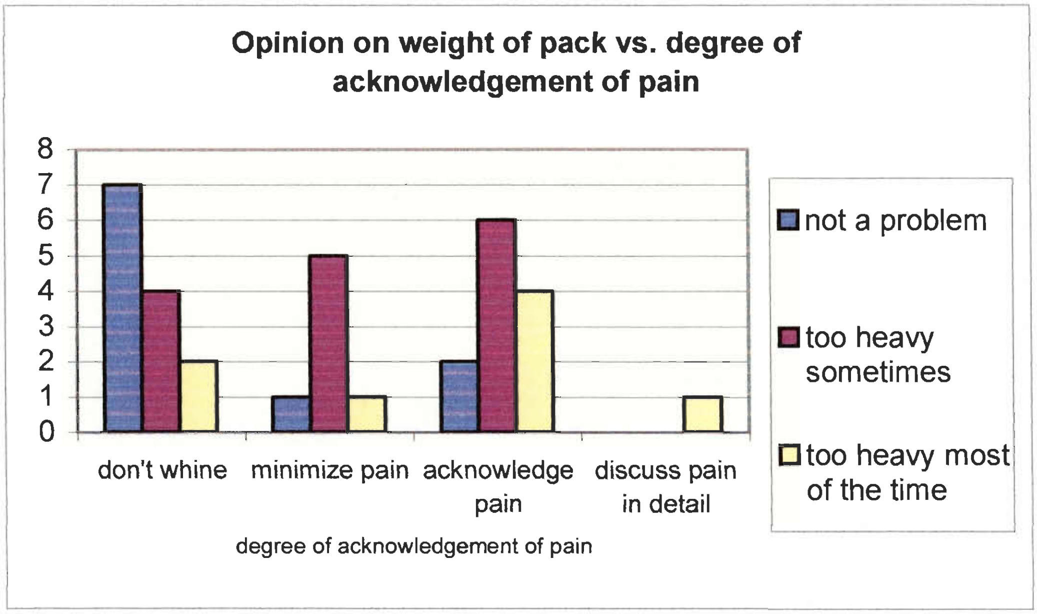
There were also some expected correlations. As expected, the greater the likelihood that there is a family history of back pain, the more likely that a student is encouraged to openly acknowledge their pain (please see Figure 4.3.4 on the next page). As seen from the figure, out of the 32 students who answered both questions, 25% (8 students) reported a family history of pain. Of these 8 students, 6 students (75%) reported that they were expected to acknowledge pain or discuss pain in detail. In contrast, of the 24 students who reported no history of familial back pain, 70.8% (17 students) felt that they were expected to "not whine" or minimize "pain". It is possible that there is a greater family history of pain among the students that are less likely to acknowledge pain, but since their family discourages the acknowledgement of pain, it will not be reported and we will never know about it.

Figure 4.3.4



Another interesting correlation was the relation between ones opinion about whether the weight of one's backpack is excessive and the degree of acknowledgement of pain (please see Figure 4.3.5 on the next page). The less likely a student is to complain about his/her back pain the more likely they are to believe their backpack is "not a problem" to carry or only too heavy "some of the time". Of the 10 students who felt their backpack was "not a problem", 80% felt they had to "not whine" or "minimize their pain". In addition, to the degree that a student minimizes his/her pain there is a greater chance that the student feels the backpack is sometimes too heavy. If the student is expected to acknowledge pain (by their family) he/she is more likely to report that the backpack is too heavy at least some of the time. Of the 23 students who reported that they felt their backpack was too heavy some of the time or most of time, 47.8% (11 students) felt they needed to acknowledge pain or discuss pain in detail.

Figure 4.3.5



Tables 4.3.2, 4.3.3, and 4.3.4 on the next page show other interesting correlations (both positive and negative) that were found during the correlation matrices. Table 4.3.2 compares how students are expected to react when experience pain with familial history of back pain and how heavy their backpack is. Some of these correlations are further explored in the figures above. Table 4.3.3 compares whether students have other supporting straps on their backpack and whether or not they experience back pain, along with comparing whether students have experienced back pain and the weight of their heaviest book. Table 4.3.4 compares whether the student has ever experienced back pain, the degree/severity of the back pain, and the consistency of their back pain.

Table 4.3.2

	Do family members have back pain?	If pain, was pain caused by pack?	When experiencing pain you are expected to:	Do family members have back pain?
How large is your smallest book?	.533	-.985	--	--
Your backpack is:	--	--	.398	--
When experiencing pain you are expected to:	--	--	--	-.415

Table 4.3.3

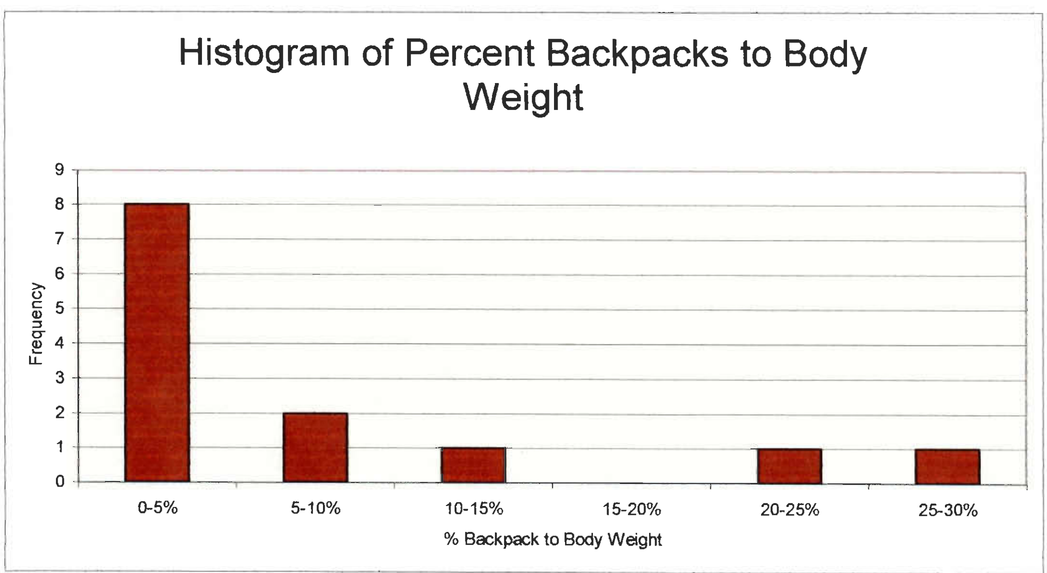
	If you have experienced pain, rate the severity	Experienced back pain?	When experiencing pain you are expected to:
Does your backpack have any supporting straps	-.481	--	--
How heavy is your heaviest book?	--	.538	-.568

Table 4.3.4

	How often do you have pain?	If pain was pain caused by the pack?	If pain is connected to the backpack what is the cause?	Has degree of pain changed?
If you have experienced pain, rate the severity	.575	-.438	.775	--
If yes, pain is:	--	--	1.000	--
How often do you have pain?	--	--	.734	.730
Has degree of pain changed?	--	-.397	.804	--

Perhaps the most unexpected finding was the fact that the students at North High School rarely carry backpacks. Even if the students reported carrying backpacks they hardly ever carried more than one book. Therefore, there was no problem with the weight of backpacks at North High School, at least in our sample population (pleases see Figure 4.3.6). As seen from the figure, of the 13 students who returned body weight and backpack weight data, 84.6% (11 students) were found to have backpacks that weighed less than 15% of their body weight. This affected the student's responses to some of the questions. Since they never carried a great deal of weight in their packs, they were less likely to feel that this was a problem elsewhere. The students were also unable to sympathize with people that carried heavy backpacks, because they had no friends that carried heavy backpacks.

Figure 4.3.6



4.4: Worcester East Middle School Backpack Survey

Since the data collection at North High School did not generate the ideal database for the mathematics lesson (the data was largely incomplete and primarily consisted of 9^{th} and 10^{th} grade students), we collected a database of the right age group (7^{th} and 8^{th} grade students) at Worcester East Middle School, a junior high school in Worcester MA. The database was generated by randomly choosing 4 mathematics classrooms at the school (two seventh grade classrooms and 2 eighth grade classrooms) and distributing the surveys to the students. This was the ideal setting to conduct the experiment, since we were personally there to answer any questions the students might have on the survey and we were also able to personally record the body weight, height, and backpack weights of the students to avoid any errors that may occur due to the measurement process. The results of this experiment yielded a much more unbiased database that could successfully be used in the future while teaching the Backpack Unit, thus enhancing the mathematics component of the unit.

Procedurally, correlation matrices were run first on the data to identify relationships in terms of item pairs. Then the interesting and significant relationships were extracted and put into cross tabulations to clarify the nature and degree of the correlations. Some of the correlation coefficients were the opposite of what we predicted. There were also many responses to questions that turned out not to be related that we had expected to be related. Table 4.4.1 on the next page gives some of the interesting and significant relationships obtained from the correlation matrices generated using the SPSS Software program. All correlations have a $p \leq .05$ and the database generated contained a sample size of 98 surveys. For a complete copy of the questions listed in Table 4.4.1, please see Appendix A.

Table 4.4.1

Significant Pearson Correlations (none greater than .05 and a sample size of 98)

	How much of the time do you actually carry your backpack on both shoulders?	Do you feel that your backpack is?	Have you experienced backache or back pain?	If you have had back pain, please rate the severity of your pain:	Backpack weight	If you have had back pain, what would you say best describes the pain?	Do you think the pain was caused by your backpack or did the backpack make it worse?
Grade (7th or 8th)	.206	-.311	-.418	-.231	.307	--	--
Do you carry a backpack to school	--	--	--	--	-.274	-.230	.246

From Table 4.4.1 above, it can be seen that there is a correlation between the grade that a student is in and whether or not they carry their backpack on two shoulders. This correlation is further explored in Figure 4.4.1 on the next page, where the grade of the student is plotted against whether or not they carry their backpack on two shoulders. As seen from the figure, out of the 42 7th grade students that were surveyed, approximately 31% of the students (13) carried their backpack on two shoulders "never" or "rarely ever" (50% of the students carry their backpack on both shoulders "sometimes", "rarely ever", or "never"). On the other hand, of the 47 8th grade students that were surveyed, approximately only 6% of the students (3) carried their backpack on two shoulders "never" or "rarely ever". The majority of the students in 8th grade carry their backpack on both shoulders "all of the time" or "much of the time".

This finding could be related to a social system. As the students get older, it is possible that it is considered okay or even "cool" for them to carry their backpacks properly, on both shoulders. Also, as the students get older their backpacks do become heavier. Alternatively the eighth graders could have felt that the "coolness" factor was outweighed by the weight of the backpacks.

This trend does not continue into ninth grade. A greater percentage of students at Worcester East Middle School carried packs—and carried their backpacks on both shoulders--

than did the students at North High School. Since Worcester East Middle School is a feeder school for North High, it raises the question of why hardly any students carry backpacks when they reach ninth grade? While the sample populations from Worcester East Middle and North High School may not entirely overlap it is more likely that at least a handful of the students that carried backpacks in middle school would have reached the North High School sample population. Also regardless of the number of books the student carries, they feel that the weight of their backpack is a problem. There is a general concern about the issue in middle school.

Another significant correlation seen from Table 4.4.1 above is between grade and backpack weight (please see Figure 4.4.2 on the next page). As seen, the backpack weight distribution for 7th grade students form a normal distribution which centers around 10-15 pounds. In contrast, the backpack weight distribution for 8th grade students centers around 15-20 pounds, which is slightly higher.

Figure 4.4.1

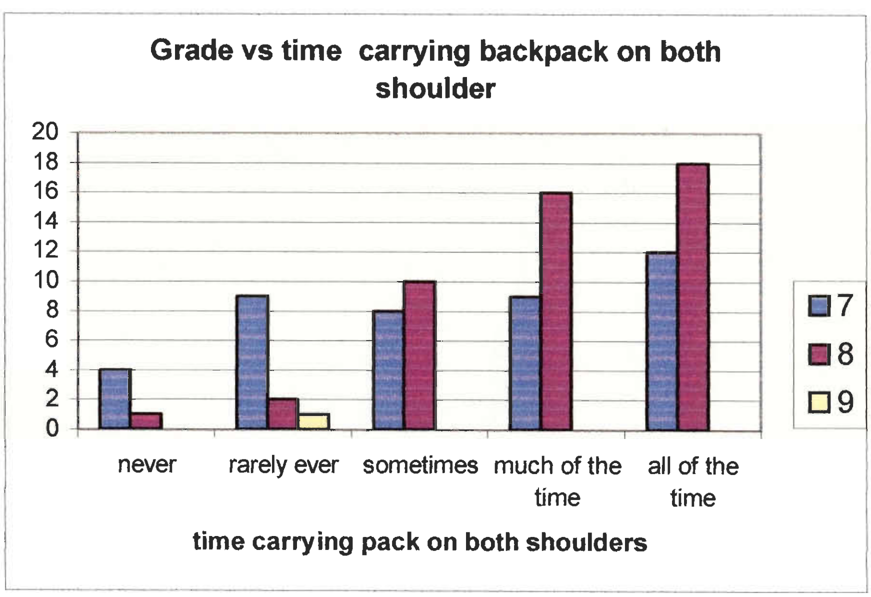


Figure 4.4.2

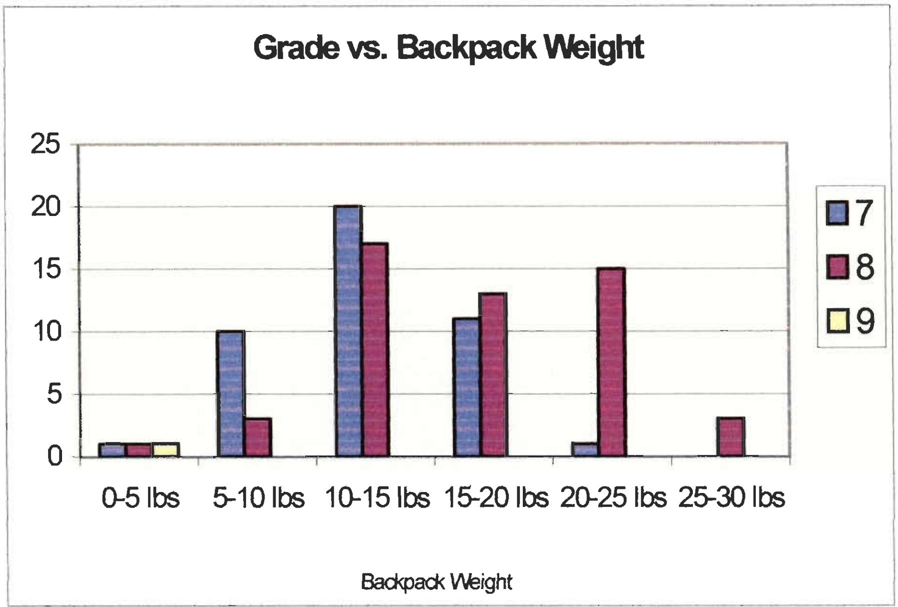
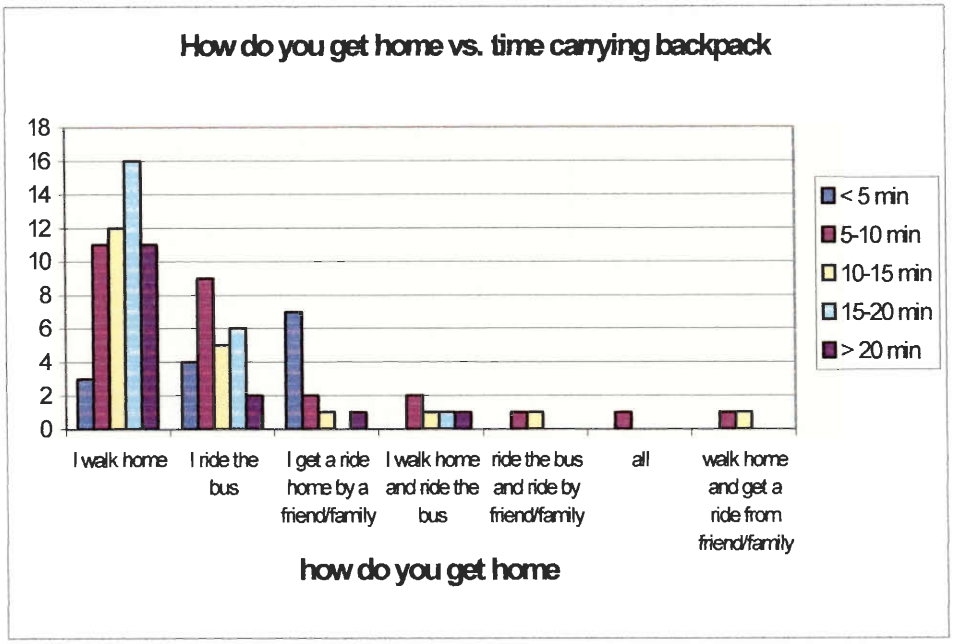


Table 4.4.2 below shows some more significant correlations amongst variables that were interesting. For example, "how do you get home" compared to "time carrying backpack showed a correlation (see Figure 4.4.3). As seen from the figure, the majority of students walk home and 74% of the students who walk home carry their backpacks for 10 minutes or greater. If these students have heavy backpacks, then they can potentially develop chronic back pain and posture problems in adulthood.

Table 4.4.2

	How long do you carry your backpack on your way back home from school yesterday?	Is your backpack designed to be slung across one or two shoulders?	How much of the time do you actually carry your backpack on both shoulders?	How many books are you carrying in your backpack today?	Backpack weight	If you have had back pain, how often have you experienced the pain?	Do you feel that your backpack is:
If yes, how often do you carry a backpack?	.199	.254	.204	.245	.220	--	--
How do you get home?	-.272	--	--	--	--	-.219	-.175

Figure 4.4.3



Another significant correlation that was found in Table 4.4.2 above is between the questions "how do you get home?" and "do you feel that your backpack is too heavy most of the times, sometimes, or not a problem". Figure 4.4.4 plots these two variables, and as seen most of the students who walk home feel that their backpack is too heavy to be carried comfortably sometimes or most of the time (of the 52 students show walk home, 73% feel their backpacks are too heavy sometimes or most of the time). In fact, of the 101 students who answered the two aforementioned questions on the survey, 77% felt their backpack was too heavy to be carried comfortably sometimes or most of the time, thus indicating that backpack weight may be a serious problem at Worcester East Middle School. However, it is the students who walk home and feel that their backpacks are too heavy are the student who are most at risk for chronic back problems in adulthood because they are carrying their heavy backpacks on their backs for extended periods of times. On the other hand, students who ride the bus or get a ride have do not have their backpacks on their backs.

Figure 4.4.4

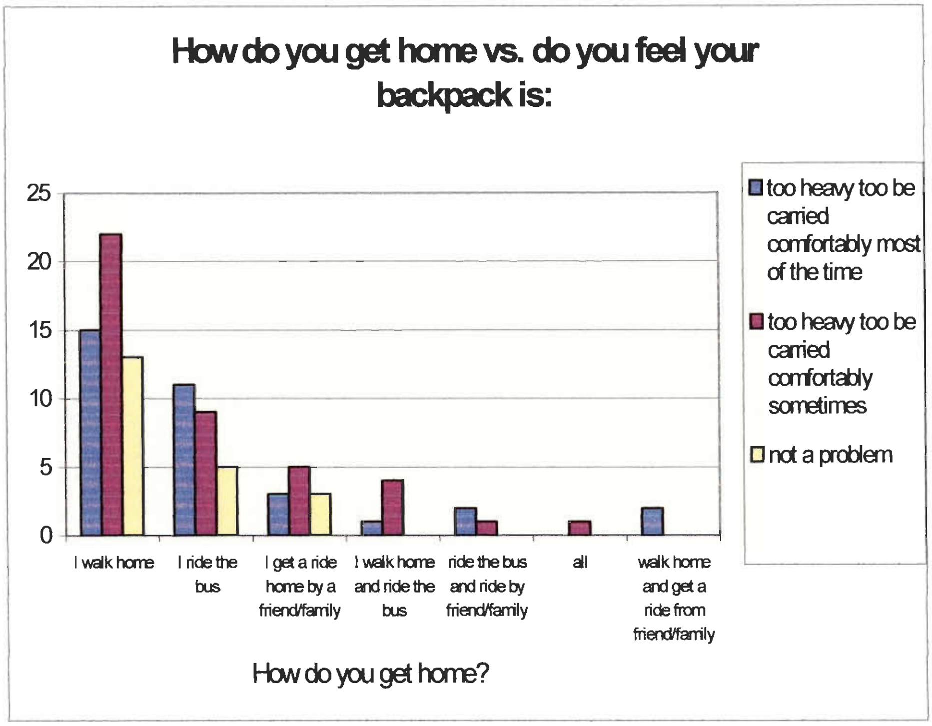
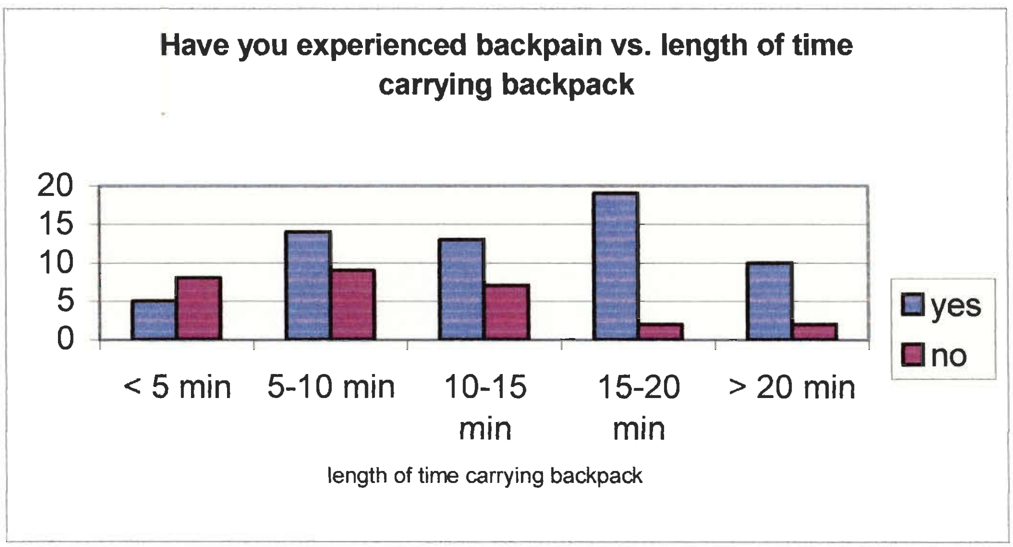


Table 4.4.3 on the next page gives a list of significant correlations that were found while comparing the how long students carried their backpack to questions about back pain. From this table, it was seen that the length of time students carry their backpacks was correlated to them experiencing back pain (please see Figure 4.4.5). Of the 91 students who answered both questions, 67.8% (61 students) said they had experienced back pain. Of the 61 students who said they had experience back pain, 68.8% (42 students) said they carried their backpacks for longer than 10 minutes every day. In contrast, of the 32.2% of students (30 students) who said they had never experienced back pain, only 26.6% (8 students) had carried their backpacks for longer than 10 minutes every day. This finding supports the fact that students who carry heavy backpacks for prolonged periods of time experience back pain due to the heavy load they carry. The results of this comparison suggest that heavy backpacks may present a problem for the students at Worcester East Middle School.

Table 4.4.3

	How many books are you carrying in your backpack today?	Do you feel that your backpack is:	Have you ever experienced backache or back pain?	When is the pain most likely to occur?	How much of the time do you actually carry your backpack on both shoulders?	If not, is the load in your backpack usually:	Do you think that the pain was caused by your backpack or did the backpack make it worse?
How long do you carry your backpack on your way back home from school yesterday?	.185	-.265	-.338	.351	--	--	--
If it wasn't a typical day, do you usually carry your backpack for:	--	--	.313	--	-.275	.491	.558

Table 4.4.5



Another interesting comparison that was observed from Table 4.4.3 is found to exist between the question "how often do you carry a backpack?" and "the amount of time their backpack is carried on both shoulders" (please see Figure 4.4.6 on the next page). As seen from the figure, of the 93 students who answered both questions, 86% (80 students) said they carried a backpack all the time and 98% of the students said they carried a backpack either all the time or 3-4 times a week. The majority of the students who carried a backpack all the time (62.5%), said they carried their backpack on both shoulders some of the time or all of the time, which was higher than anticipated.

Figure 4.4.6

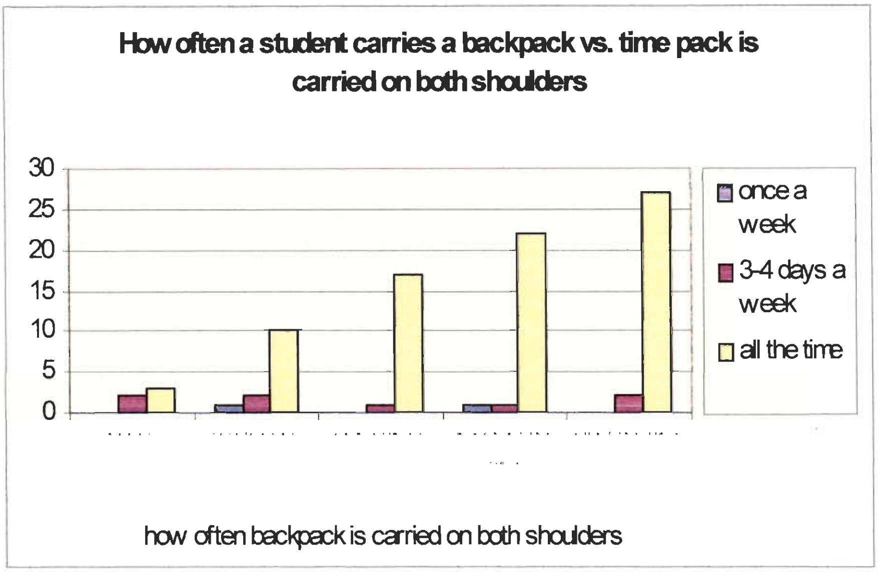


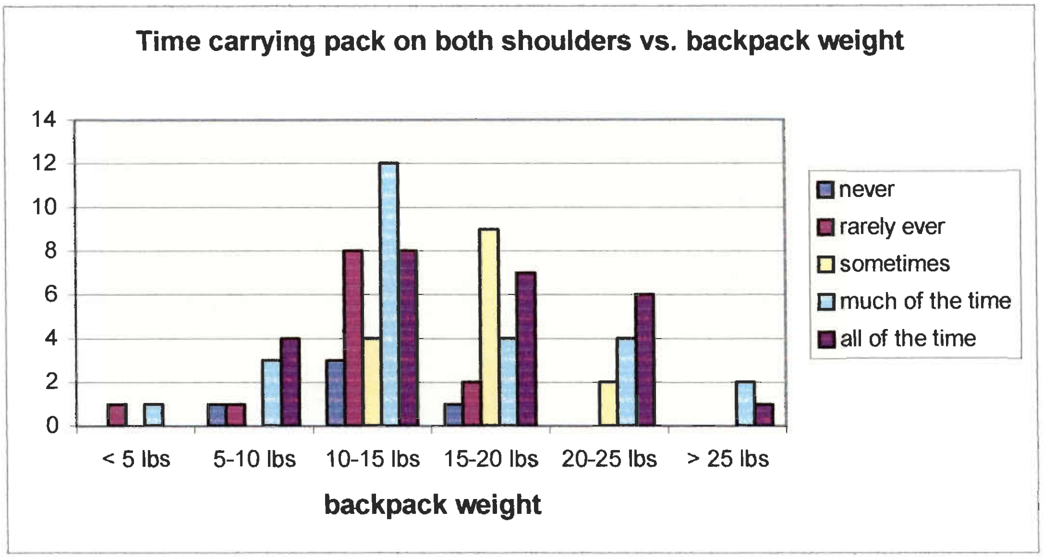
Table 4.4.4 on the next page shows the significant correlations that were found when questions pertaining to backpack weight, back pain, and the familial history of back pain were compared against one another. An interesting correlation that was observed from the table is when backpack weight is compared to time the backpack is carried on both shoulders (please see Figure 4.4.7). As seen from the figure, students who never or rarely ever carry their backpack on both shoulders have a mean backpack weight of about 10-15 pounds. Students who sometimes carry their backpack on both shoulders have mean backpack weight of about 15-20 pounds, whereas students who carry their backpack on both shoulders much of the time have a mean backpack weight of 10-15 pounds. On the other hand, students who always carry their backpack on both shoulders have a mean backpack weight of 20-25 pounds. As seen, in

general, as the weight of the backpack increases, students tend to carry their backpack on both shoulders more often.

Table 4.4.4

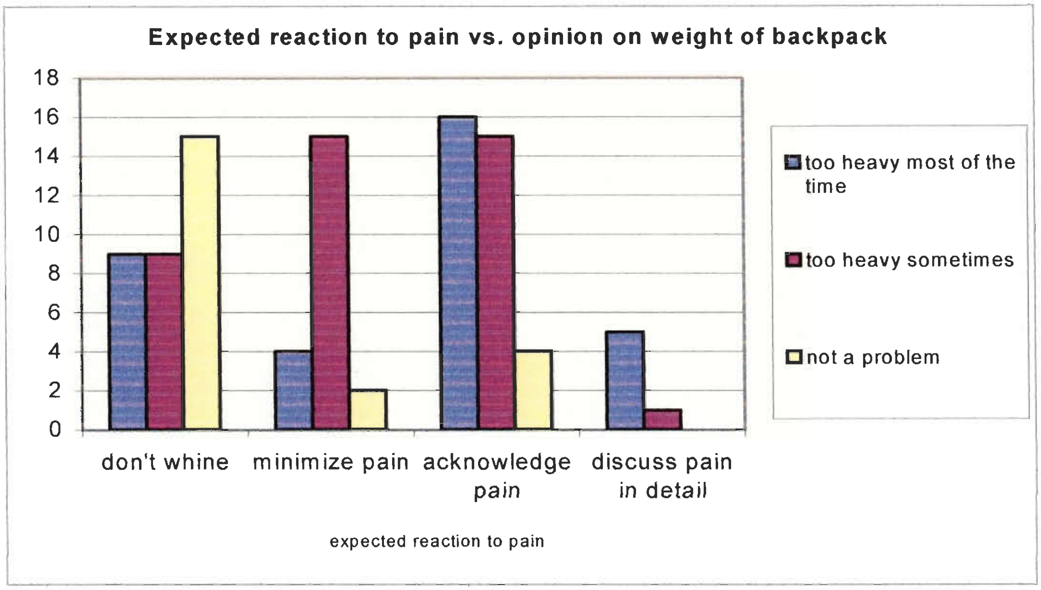
	Do you feel that your backpack is:	Have you experienced backache or back pain?	If you have had back pain, please rate the severity of your pain:	Backpack weight	If you have had back pain, what would you say best describes the pain?	Among your family and friends, which of the following best describes how you are expected to react to pain?	If you have had back pain, how often have you experienced the pain:
Do you carry a backpack at any other time besides when going to school?	.345	.231	.256	-.256	--	--	--
Is your backpack designed to be slung across one or two shoulders?	.229	--	--	--	--	--	--
How much of the time do you actually carry your backpack on both shoulders?	--	--	--	.261	--	--	--
How many books are you carrying in your backpack today?	-.239	--	--	.468	-.302	--	--
If not (typical), is the load in your backpack usually:	.376	--	.405	--	--	--	--
What is the estimated weight of all personal items you carry compared to the heaviest book in your backpack?	--	-.202	--	--	--	--	--
Do you feel that your backpack is:	--	.469	.406	-.250	--	-.377	.344
If you have had back pain, please rate the severity of your pain:	--	--	--	--	--	--	.279

Figure 4.4.7



Another interesting comparison that was observed from Table 4.4.4 is the relationship between the student's expected reaction to pain versus their opinion on the weight of their backpack (see Figure 4.4.8). It was anticipated that if students were taught to no acknowledge pain and minimize it, they would be less likely to "complain" and feel that their backpack was too heavy for them to carry. In contrast, students who were expected to discuss pain in detail would probably acknowledge that their backpack was too heavy to carry. As seen in the figure below, of the 41 students who answered that they were expected to acknowledge pain or discuss pain in detail, 90% (37 students) felt that their backpack was too heavy most of the time or sometimes (51% felt their backpack was too heavy most of the time).

Figure 4.4.8



After comparing some of the interesting correlations found within the backpack survey, it was time to analyze the backpack weights for all the students who were measured, and determine if heavy backpacks were a problem at Worcester East Middle School. The percent backpack to body weight for each student in all four of the math classes was calculated and analyzed per class, as can be seen in the figures below.

Figure 4.4.9 below depicts the distribution of the backpack weights in terms of percent body weight (calculated by backpack weight/body weight) for the Lynch math classroom. As seen from the figure, of the 28 students who were measured, 79% of the students (22 students) had backpacks that weighed less than 15% of their body weight. The majority of the students in the classroom had backpack weights that ranged from 10-15% of their backpack, thus establishing that the majority of this classroom was not in danger of chronic back problems and posture problems due to heavy backpacks.

Figure 4.4.9

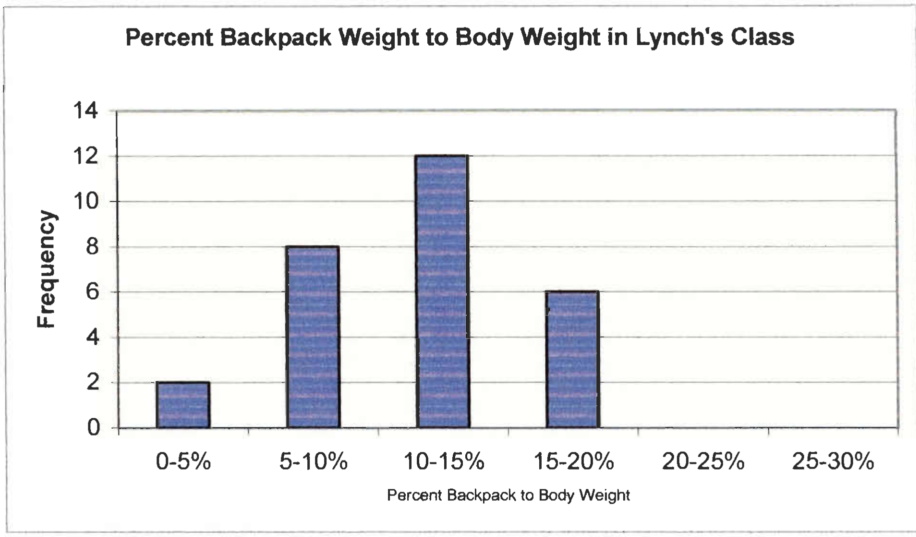


Figure 4.4.10 on the next page depicts the distribution of the backpack weights in terms of percent body weight (calculated by backpack weight/body weight) for the Lamberto math classroom. As seen from the figure, of the 24 students who were measured, 79% of the students (19 students) had backpacks that weighed less than 15% of their body weight. The majority of the students in the classroom had backpack weights that ranged from 5-15% of their backpack, thus establishing that the majority of this classroom was not in danger of chronic back problems and posture problems due to heavy backpacks.

Figure 4.4.11 on the next page depicts the distribution of the backpack weights in terms of percent body weight (calculated by backpack weight/body weight) for the Sedares math classroom. As seen from the figure, of the 17 students who were measured, 88% of the students (15 students) had backpacks that weighed less than 15% of their body weight. The majority of the students in the classroom had backpack weights that ranged from 5-10% of their backpack, thus establishing that the majority of this classroom was clearly not in danger of chronic back problems and posture problems due to heavy backpacks.

Figure 4.4.10

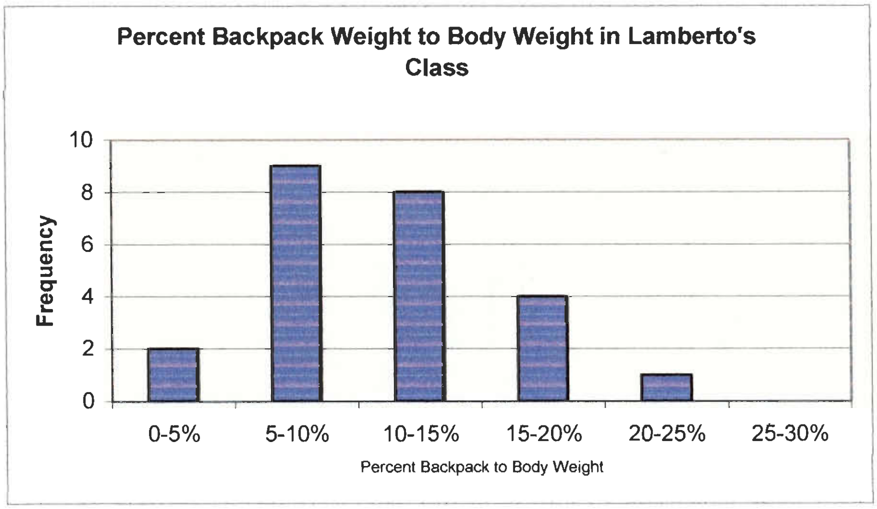


Figure 4.4.11

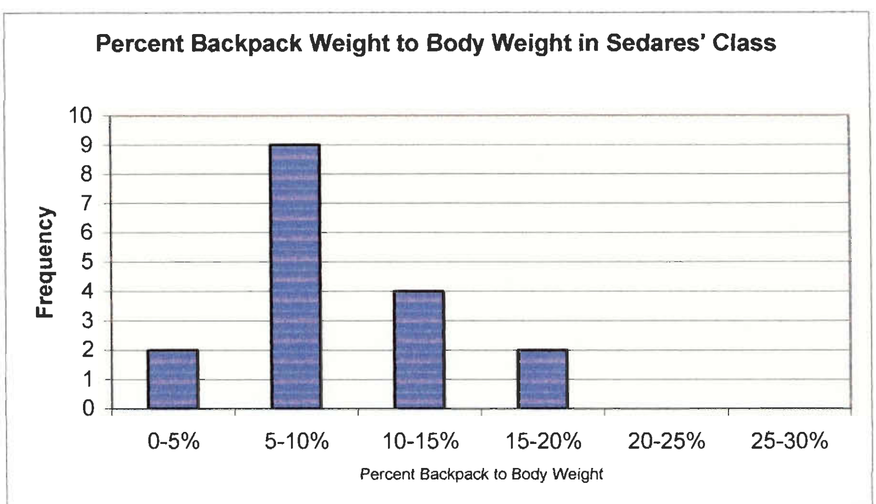
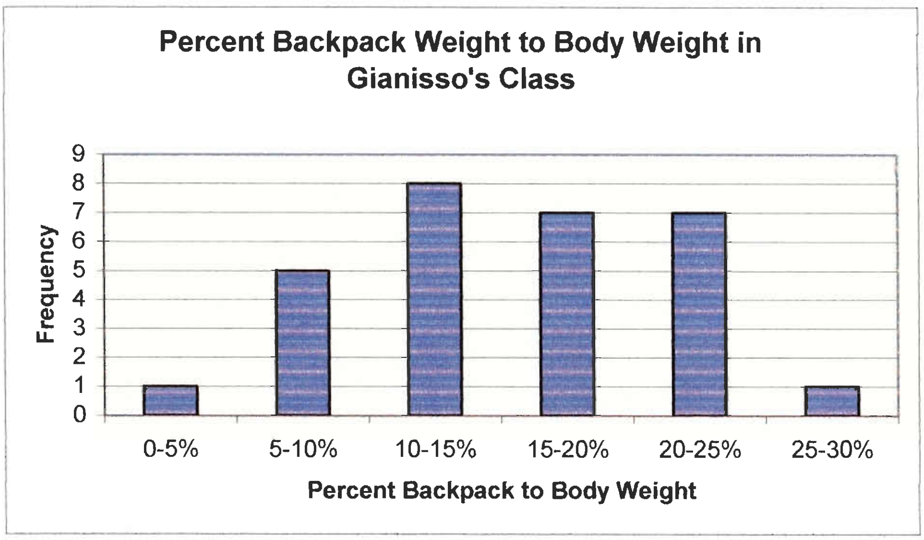


Figure 4.4.12 on the next page depicts the distribution of the backpack weights in terms of percent body weight (calculated by backpack weight/body weight) for the Gianisso math classroom. As seen from the figure, of the 29 students who were measured, 48% of the students (14 students) had backpacks that weighed less than 15% of their body weight. Clearly, the majority of the students in this classroom carried backpacks that were more than 15% of their

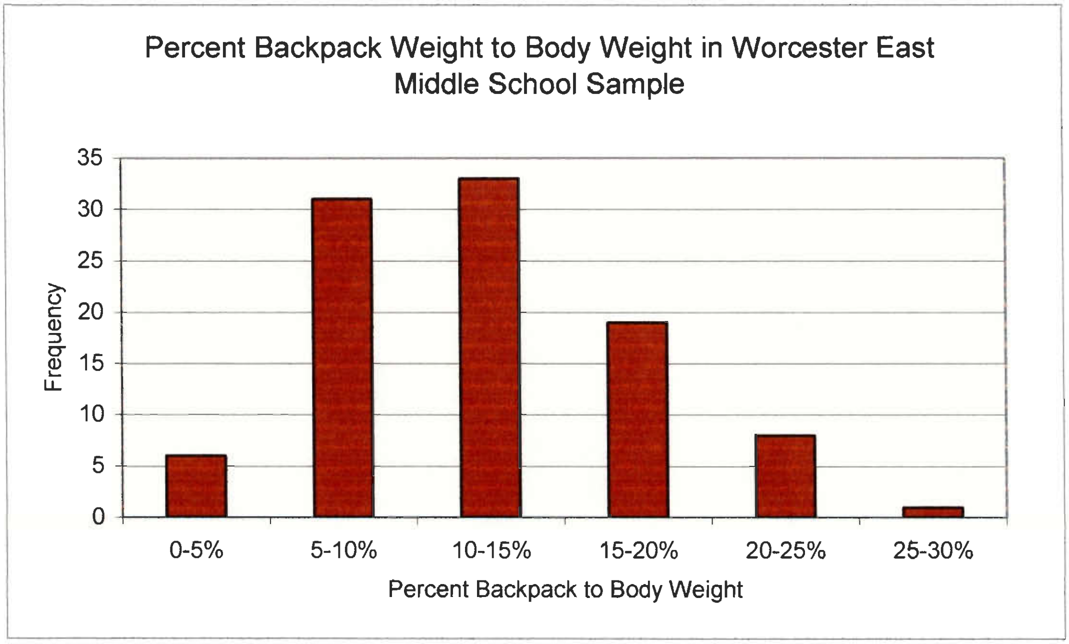
backpack, putting them at risk for back related problems both now and in adulthood. As seen, one of the students in this classroom was carrying a backpack that was between 25-30% of his body weight!

Figure 4.4.12



By compiling the data found from these four math classrooms, the backpack weights of all the students sampled at Worcester East Middle School could be observed as seen in Figure 4.4.13 on the next page. Still, there was a problem for roughly 25% of the students in our survey sample, which was fairly representative. Twenty-six of the ninety-eight students reported backpacks weighing over 15% of their body weight. Thus, 25% of the school (if our sample corresponds to the larger population of Worcester East Middle School) is at risk of back problems associated with dangerously heavy back packs.

Figure 4.4.13



Percent Backpack Weight to Body Weight in Worcester East Middle School Sample
Frequency
35
30
25
20
15
10
5
0
0-5%
5-10%
10-15%
15-20%
20-25%
25-30%
Percent Backpack to Body Weight

4.5: Pre Course Evaluation

The pre-course survey was administered to the eleven students in the health class at North High School. The purpose of the survey was to gather information from the students regarding how much they enjoyed their current mathematics, science, and health classes (since these were the subjects that were introduced in the Backpack Unit). The survey was so large that we had to segment the database in order to analyze it in SPSS, the statistical package that was used. Many of the questions had significant correlations, however for a few questions over half of the students answered, “I don’t know” making further analysis of those questions moot. Many of the other questions were correlated as expected.

Some of the questions on the pre course evaluation (please see Appendix F) asked students to choose various adjectives to describe science, such as facts or concepts, easy or hard, traditional or new etc. Correlation matrices were run on the students’ responses for these questions, and the significant correlations that were returned may be seen in Table 4.5.1 below and Table 4.5.2 on the next page.

Table 4.5.1

Significant Pearson Correlations (none less than .05 and 11 cases)

	Science is best described by concepts	Science is described as stable	Science is described as challenging	Science is described as traditional	Science is described as new	Science is competitive
Science is best described by facts	-.950	--	--	--	--	--
Science is best described by concepts	--	.630	-.630	--	--	--

Table 4.5.2
Significant Pearson Correlations (none less than .05 and 11 cases)

	Science is described as lonely	Science is described as easy	Science is described as hard	Science is described as traditional	Science is described as new	Science is described as competitive
Science is described as lively	-.951	-.683	.683	-.788	.745	.683
Science is described as lonely	--	--	--	.834	.745	--
Science is described as easy	--	--	--	--	--	-.714

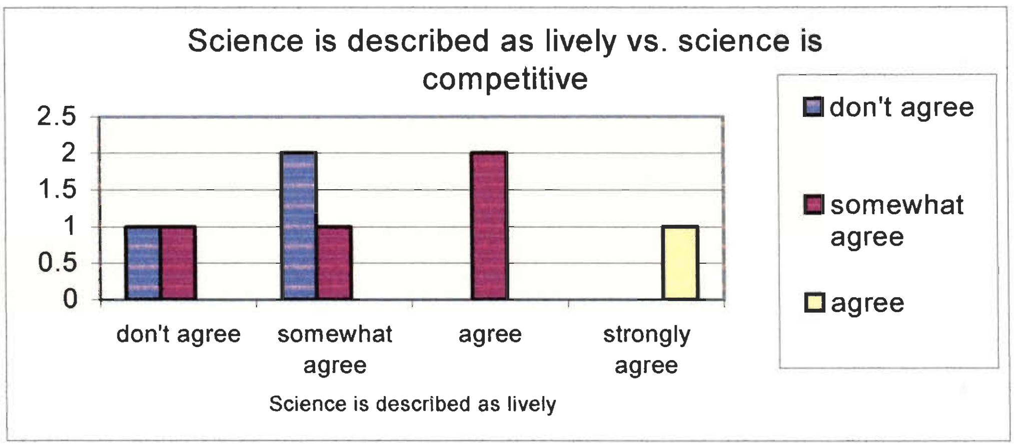
Table 4.5.3
Significant Pearson Correlations (none less than .05 and 11 cases)

	Science is competitive	Science is technical	Science is cooperative	How often do you learn new things in health?	Is health important in your life?
Science is described as hard	.714	--	--	--	--
Science is human	--	-.916	--	--	--
Science is competitive	--	--	-.937	--	--
Enjoying science class?	--	--	--	-.711	-.620

Table 4.5.3 above shows the significant correlations between adjectives that students used to describe science and how much they enjoy their science and health classes. As expected, there are strong negative correlations between students who think of science as "human" versus those who think of it as "technical" and between students who think of science as "competitive" versus those who think of it as "cooperative".

From Table 4.5.2 above, it is seen that there is a strong correlation between students who feel that science is lively and students who feel that science is competitive (please see Figure 4.5.1). As seen from the figure, all of the students who strongly agreed that science could be described as lively also strongly felt that science could be described as competitive.

Figure 4.5.1



Another significant correlation that was seen in Table 4.5.2 was between students who felt that science was lively and easy (please see Figure 4.5.2 below). In this case, students who felt that science could be described as lively did not believe that science was easy. As seen, the 5 students who agreed that science was easy did not agree or somewhat agreed that science was lively. Furthermore, anyone that strongly agreed that science was lively strongly disagreed that science was easy.

As seen from Table 4.5.2, a fairly strong correlation was also observed between students who felt that science was lonely and those who felt that science was traditional (please see Figure 4.5.3). Half of the 8 students who answered both questions felt that science could not be described as traditional, and 75% of these students felt that science could also not be described as lonely. Conversely, students who agreed that science was traditional also felt that science was lonely.

Figure 4.5.2

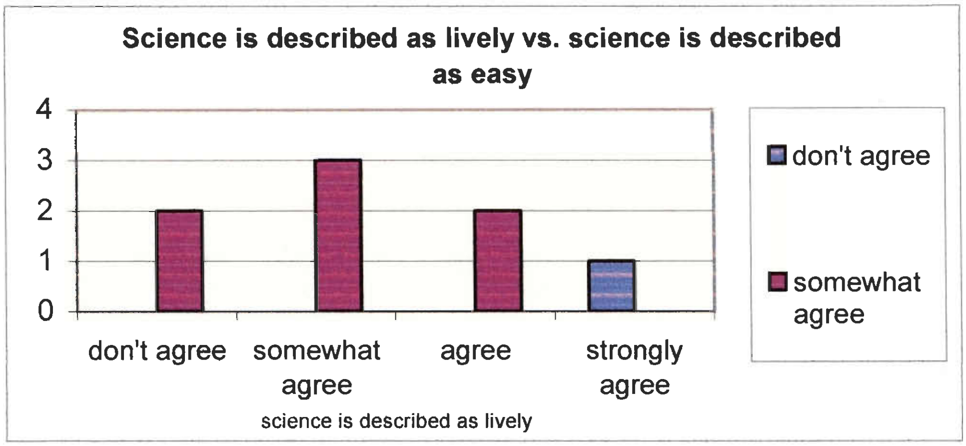
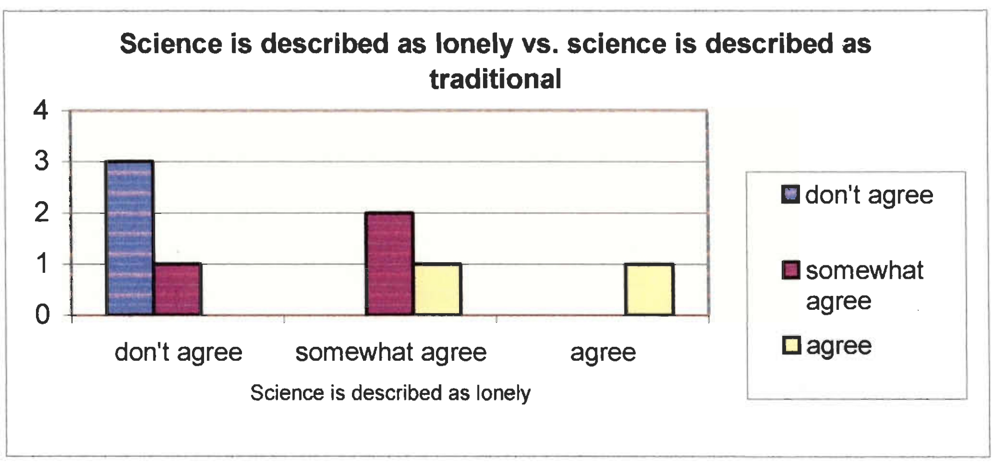


Figure 4.5.3



To summarize, there were many interesting relationships and non-relationship findings in the data from the pre-course survey. The students who thought that science was a lively subject were more likely to think science was hard. Perhaps when a course is too easy students lose interest? It seemed these students were more likely to have a positive view of a subject when they were challenged. The students who believe that science is hard are also more likely to believe that science is competitive.

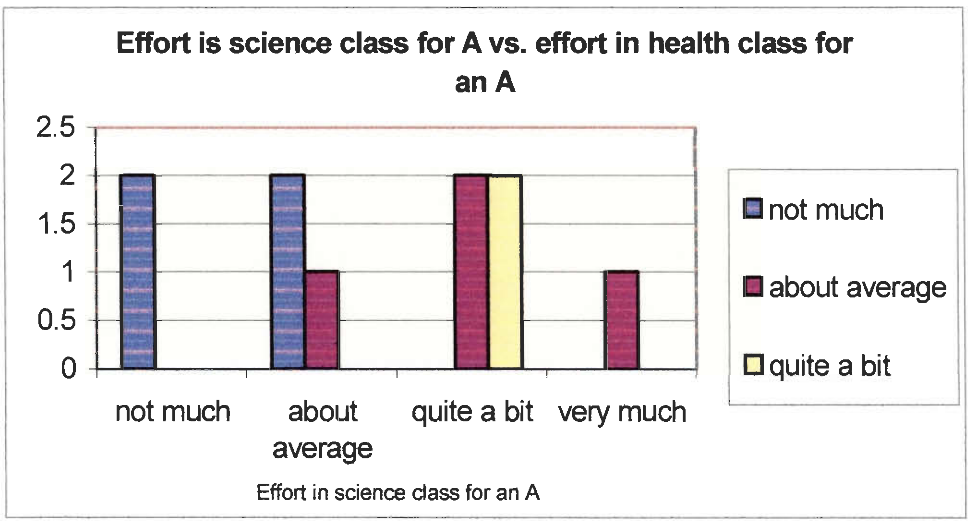
Important correlations were also found between the amount of effort students put into their health and science classes, how important health and science were to their future schoolwork and to their life, and if they wanted to study health and science in the future. The significant correlations between these questions may be seen in Table 4.5.4 below.

Table 4.5.4
Significant Pearson Correlations (none less than .05 and 11 cases)

	Effort in health to get A?	Effort in health right now?	How much more learning health topics in the future?	Do you expect to do well in health?	Importance of health in future schoolwork?	More or less time studying science topic?
Effort in science class for an A?	.700	.710	--	--	--	--
Effort in science right now?	--	.762	.582	--	--	--
Do you expect to do well in science?	--	--	--	.658	--	--
Is science important in your life?	--	--	--	--	.760	--
Is health important in your life?	--	--	--	--	--	.698

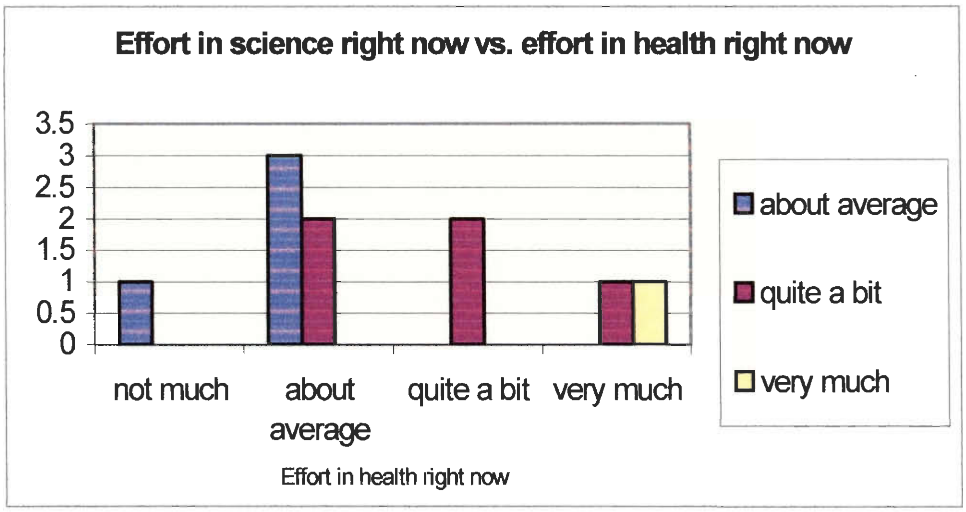
As seen from Table 4.5.4 above, there is also a strong correlation between the levels of student effort exhibited in science and health class even though not as much work was required in health and it was not as serious of a class. In fact, the relative effort the students put forth to get an A in science is associated with the effort they will put into health class to get an A. This relationship can be further seen in Figure 4.5.4 below. As seen, of the 10 students who answered both the following questions on the pre course evaluation, “how much effort do you need to put into your science class for an A” and “how much effort do you need to put into your health class for an A”, 40% replied that not much effort was needed in health class. On the other hand, 20% of the students replied that not much effort was needed to get an "A" in science class. Fifty percent of the students felt that quite a bit or very much effort was needed in science class to get an "A", compared to twenty percent who felt that quite a bit of effort was needed to get an "A" in health class. Despite these differences though, on average, students put in similar amounts of effort in both these classes to get an "A".

Figure 4.5.4



Similar to the comparison found in Figure 4.5.4, Figure 4.5.5 below compares the relationship between the effort put forth in science class versus the effort put forth in health class by the students. As seen from Table 4.5.4 above, there is a positive relationship between the two questions, which supports the finding of the comparison in Figure 4.5.4. As seen from Figure 4.5.5, ten students answered both of the aforementioned questions, and 60% of the students put in "quite a bit" or "very much" of effort in their science class right now, compared to 40% of the students who put in "quite a bit" or "very much" effort in their health class right now. As seen, students appear to put in similar amounts of effort for both classes, although science classes are generally thought to be more demanding than health classes.

Figure 4.5.5



Another interesting correlation that was observed from Table 4.5.4 is between students who felt they would do well in science class compared to those who felt they would do well in health class (see Figure 4.5.6). Of the 11 students who answered both these questions, 64% (7 students) felt they would do very well in science class and 55% (6 students) felt they would do very well in health class. However, 27% of the class felt they would perform average in science class, whereas only 9% of the class felt they would perform average in health class. Therefore, in general, students expect to perform similarly in both health and science class, although more people expect to perform above average in health class compared to science class, perhaps attributed to the fact that health class is easier than science class.

Figure 4.5.6

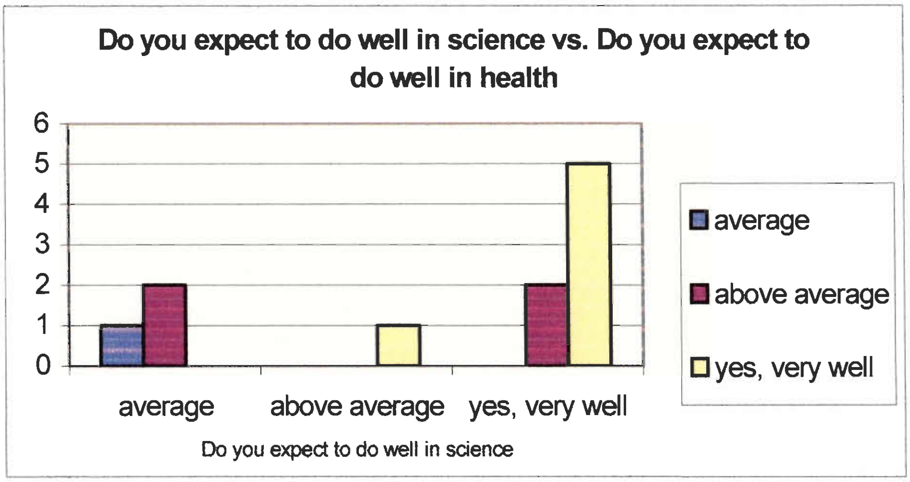


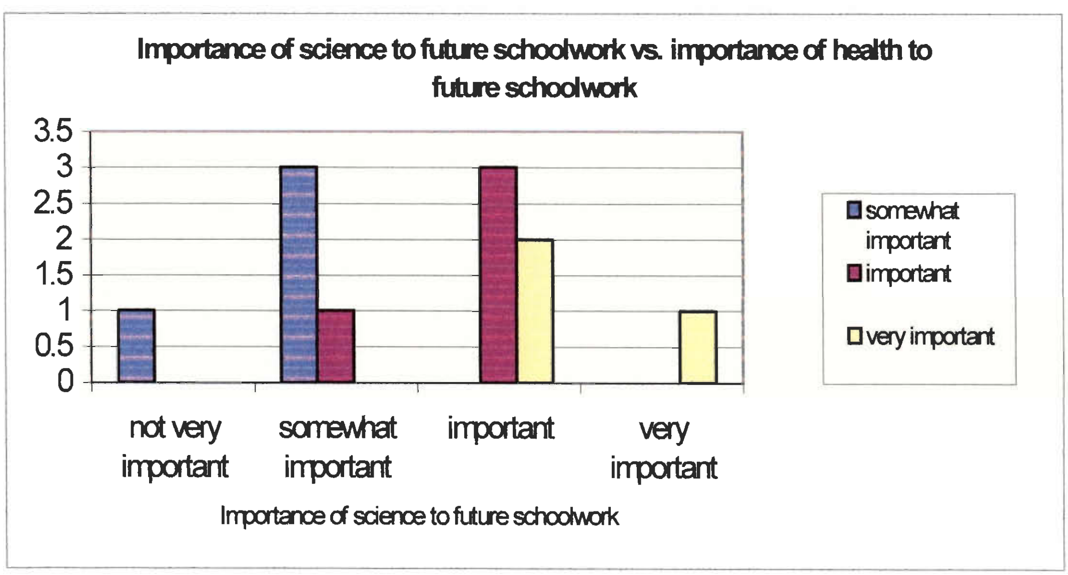
Table 4.5.5 on the next page gives significant correlations for questions regarding the relative importance of health and science to future schoolwork, whether students want to spend more or less time studying each of these subjects, and how much they want to study these topics in the future. As seen from the table, there is a strong positive correlation between students who feel that science is important in the future and students who feel that health is important in the future (please see Figure 4.5.7 on the next page). As seen from this figure, 11 students answered the aforementioned questions, and of them 55% (6 students) felt that health was important or very important to their future schoolwork, and 64% (7 students) felt that science was important or very important to their future schoolwork. As seen, the majority of the class feels that both science and health are important courses in their future schoolwork. Of the 11 students, 36% (4 students) felt that both science and health were somewhat important subjects for their future schoolwork.

Table 4.5.5

Significant Pearson Correlations (none less than .05 and 12 cases)

	Importance of health in future schoolwork	How much more learning health topics in the future?	More or less time studying science topic?	More or less time studying health topic?	How much more learning science topics in the future?	How much do you enjoy physical science?
Importance of science to future schoolwork	.813	.570	--	--	--	-.713
Importance of health in future schoolwork	--	.760	.688	--	.527	--
More or less time studying science topic?	--	.567	--	.606	--	--
How much more learning science topics in the future?	--	.661	--	--	--	--

Figure 4.5.7



Another correlation that was observed from Table 4.5.5 is between the questions: "more or less time studying a science topic?" vs. "more or less time studying a health topic?" As seen from Figure 4.5.8 below, all 12 of the students in the class answered these questions, and 33% of them (4 students) wanted to spend less time studying science whereas 50% of them (6 students) wanted to spend much less time and less time studying health. Conversely, 17% of the students (2 students) wanted to spend more time or much more time studying science in the future and 8% (1 student) wanted to spend much more time studying health in the future. Thus as seen, about the same percentage of the class wants study health and science in the future, although this percentage is significantly lower than the majority of the class. The highest percentage of the class wishes to spend less time studying science and health topics in the future.

Figure 4.5.8

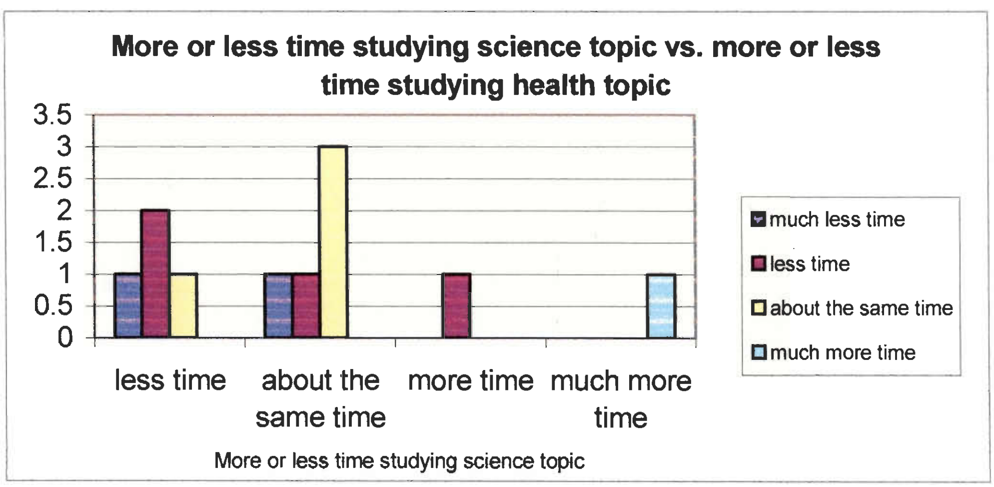


Table 4.5.5 above also shows that there is a positive correlation between students perception of the importance of health in future schoolwork compared to how much more they would like to study health in the future (please see Figure 4.5.9 below). As seen from the

figure, 11 students answered both of these questions, and of them 55% (6 students) wanted to learn "quite a bit" or "much more" about health topics in the future and 64% (7 students) felt that health was important or very important in future schoolwork. As can be seen, the majority of students in this health class wanted to learn more about health topics in the future and felt that these topics would be very important in their future schoolwork (perhaps because they would like jobs in the health profession?).

Figure 4.5.9

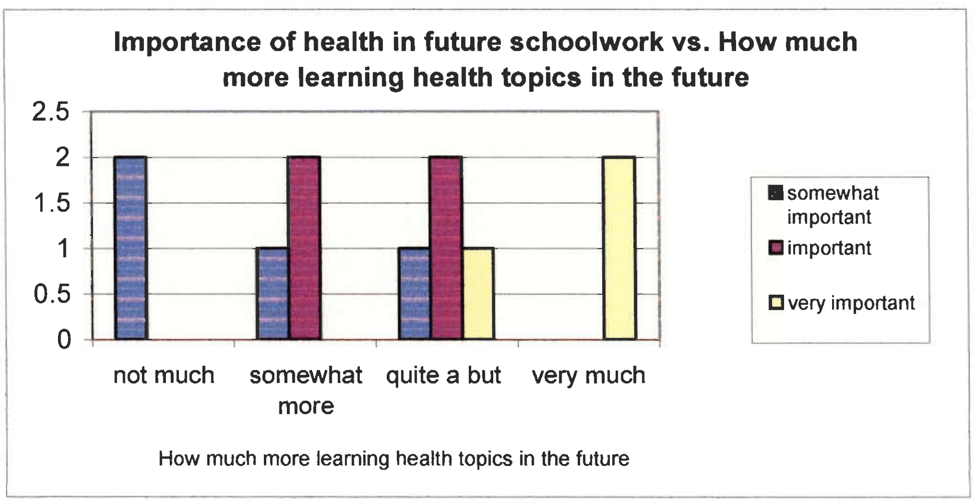


Table 4.5.6 further gives some significant correlations that were found in the pre course evaluation. The correlations found in this table largely involve comparing questions such as how much students enjoy their science class to whether they want to become scientists and their perception of scientists and science. As seen, Table 4.5.6 shows that there was a negative correlation between the amount of effort students put into their science classes to get an "A" and whether science was important to them or not (please see Figure 4.5.10 on the next page). As seen from the figure, 10 students answered both of these questions, and 60% of them (6

students) felt that science was important or very important to their lives. However, of these 6 students, 50% of them were putting in "not much" or "average" effort in science class at the moment to earn an "A". Perhaps these students were so "scientifically oriented" they did not need to put forth a lot of effort in the class to earn good marks, hence explaining their aptitude and inclination toward the subject. However, in general, 50% of the students (5 students) felt they were putting in "quite a bit" or "very much" effort in their science class to earn an "A".

Table 4.5.6
Significant Pearson Correlations (none less than .05 and 12 cases)

	Science is described by the real world	Confidence in leading scientists	Is science important to your life?	Job using science material?	Got to college to become scientist/ engineer	Benefits of science outweigh disadvantages
How much do you enjoy life science?	-.752	.830	--	--	--	--
Effort in science class for an A?	.810	--	-.639	.836	.758	-.683

Figure 4.5.10

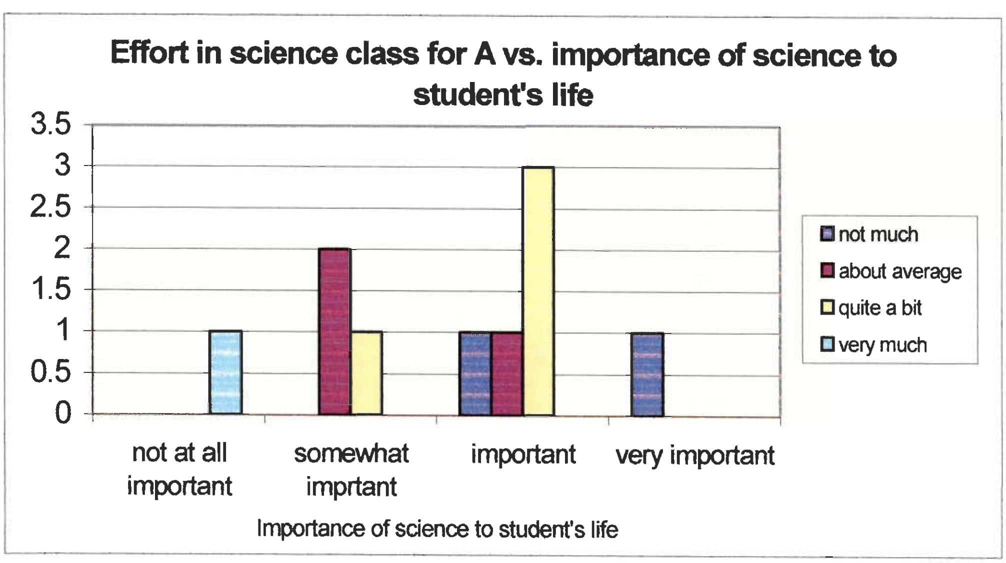


Table 4.5.6 above also indicated that there was a strong positive correlation between how much effort students were putting into their science class for an "A" and the likelihood the student would go to college and become a scientist (please see Figure 4.5.11 below). As seen from the figure, 8 students answered both of these questions, and 75% of them (6 students) felt that it was "not likely" or "not at all likely" that they would go to college to become a scientist or engineer. Of these 6 students, 67% of them (4 students) were putting "quite a bit" of effort in their science class and the remaining 33% (2 students) were putting "about average" effort into their science class for an "A". It is interesting to note that the one student who felt it was "likely" that he/she would go to college and become an engineer felt they were weren't putting in a lot of effort in science class to get an "A". This supports the above hypothesis that scientists who are interested in science have a natural aptitude for the subject and thus do not have to put in a lot of effort for science class to do well.

Figure 4.5.11

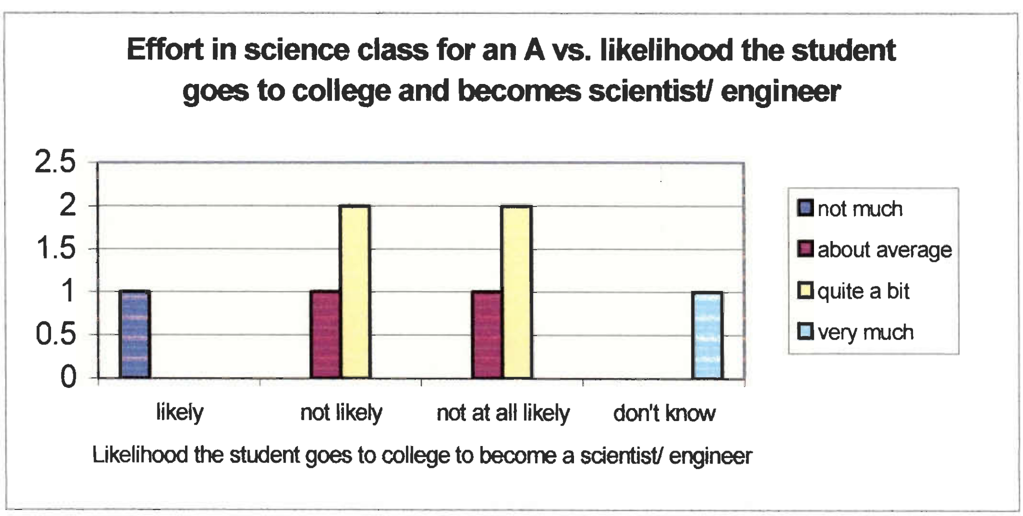


Table 4.5.7 on the next page shows significant correlations that were found when the questions "effort in science class" and "importance of science in your life" were compared to

whether students wanted to study science in the future, their perception on scientists and science, and how much they enjoyed the subject. As seen, there was a negative correlation between how much students enjoy life science and their effort in science class now, which was surprising. The negative correlation between effort in science class for an "A" and the importance of science to students lives was expected. There was also a strong positive correlation between the amount of time students want to spend studying science to the importance of science in their lives.

Table 4.5.7
Significant Pearson Correlations (none less than .05 and 11 cases)

	How much do you enjoy life science?	Science is described as the real world	Effort in science class for A?	Importance of science to future schoolwork ?	More or less time studying science topic?	Benefits of science outweigh disadvanta ges
Effort in science right now?	-.656	.810	--	--	--	--
Is science important to your life?	--	--	-.639	.674	.708	.687

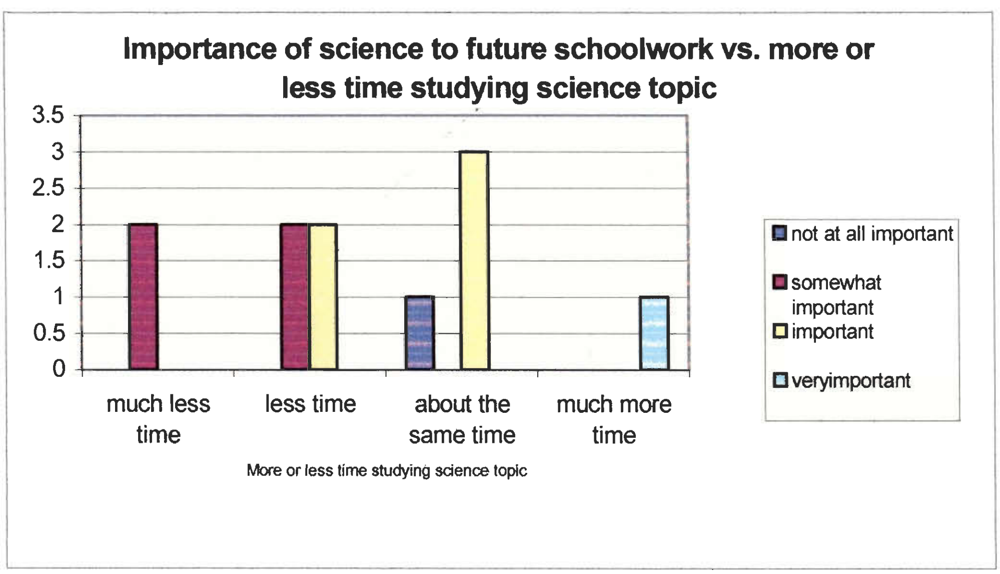
Table 4.5.8 on the next page shows the significant correlations that arose when the question "importance of science to future schoolwork" was compared against students' perceptions of science and how much time they want to spend learning science in the future. Figure 4.5.12 on the next page further explores the relationship between the importance of science to future schoolwork and whether students want to spend more or less time studying science in the future. As seen from the figure, 11 students answered both of these questions on the pre course evaluation, and 55% of the students (6 students) indicated they wanted to spend "less time" or "much less time" studying science. Of these 6 students, 66% (4 students) felt that science was somewhat important to future schoolwork and 33% (2 students) felt it was

important to future schoolwork. On the other hand, 45% of the students said they wanted to spend about the same time or more time studying science, and of this 45%, 80% of the students felt that science was either important or very important to future schoolwork.

Table 4.5.8
Significant Pearson Correlations (none less than .05 and 10 cases)

	More or less time studying science topic?	How much more learning science topics in the future?	Science is describe d as easy	Science is described as hard	Intelligence in understanding science for job?	Benefits of science outweigh disadvantages
Importance of science to future schoolwork	.570	.559	.714	-.714	.559	.655

Figure 4.5.12



A correlation between the importance of science to future schoolwork and the amount of intelligence needed in understanding science oriented jobs was also seen in Table 4.5.8 (please see Figure 4.5.13). As seen from this figure, 10 students answered both these questions, and 90% (9 students) felt that science was important or somewhat important to their future schoolwork, and of these 9 students, 56% felt (5 students) that “anyone” or “most people” could understand science oriented jobs.

Figure 4.5.13

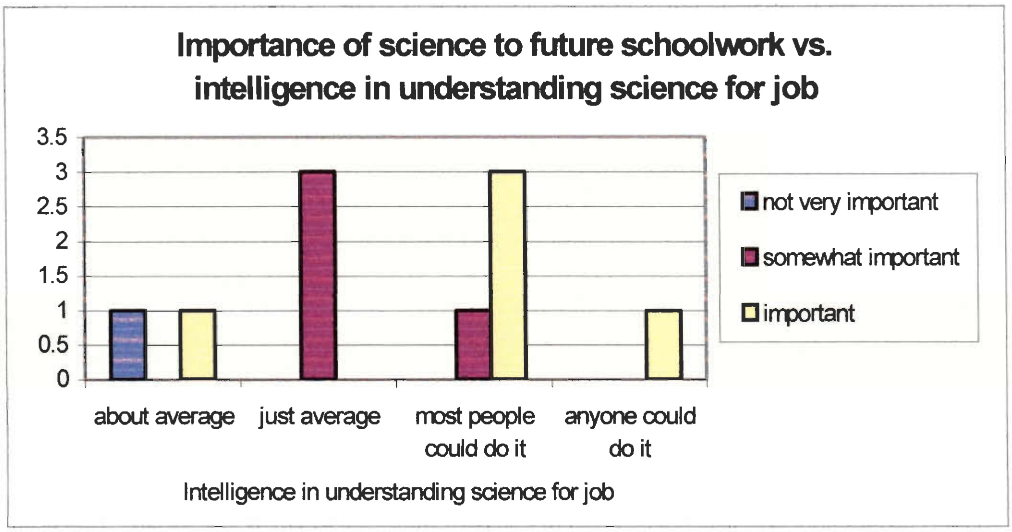
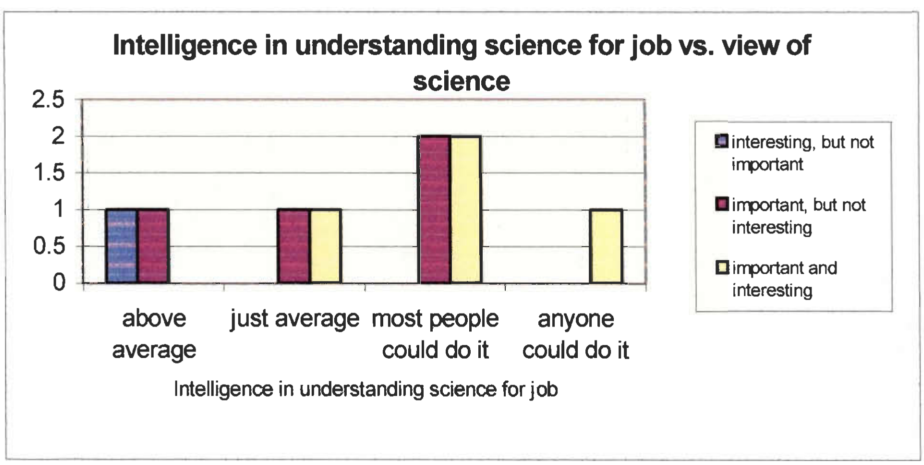


Table 4.5.9 on the next page displays some more significant correlations that were found while analyzing the pre course evaluation. This table largely compares students attitudes toward science and scientists, their perception of science, and desire to study science in the future. An interesting correlation that is observed from this table involves the students view of science and intelligence in understanding science for a job (please see Figure 4.5.14). As seen from the figure, of the 9 students who answered both the aforementioned questions, 56% (5 students) felt that either most people or anyone had enough intelligence to obtain a scientific job. Of these 5 students, 60% (3 students) felt that science was both important and interesting, while 40% felt that that science was important but not interesting. The one student who felt that science was interesting but not important felt that an individual had to have above average intelligence in order to handle a job in the scientific field.

Table 4.5.9
Significant Pearson Correlations (none less than .05 and 9 cases)

	Confidence in leading scientists?	Controversial science material not mentioned until resolved	Intelligence in understanding science for job?	Science helps me to learn to think more clearly	View of science?	Benefits of science outweigh disadvantages
How much more learning science topics in the future?	-.682	.717	--	--	--	--
Science is described as lively	--	--	-.703	-.710	--	--
Intelligence in understanding science for job?	--	--	--	--	.639	.658

Figure 4.5.14



Another interesting correlation that was observed from Table 4.5.9 above involved how much science the students want to learn in the future and whether controversial science material should be presented in class before it is resolved (please see Figure 4.5.15). As seen from the figure on the next page, 9 students responded to both of these questions, and 67% of the students (6 students) felt that they wanted learn "none" or "not much" more science in the future. Of these 6 students, 67% (4 students) felt that controversial material should be presented in a science class before it is resolved. This is contrary to what was expected, since it was anticipated that students who wanted to study science in the future would be more interested in hearing about the latest developments in the scientific field.

Figure 4.5.15

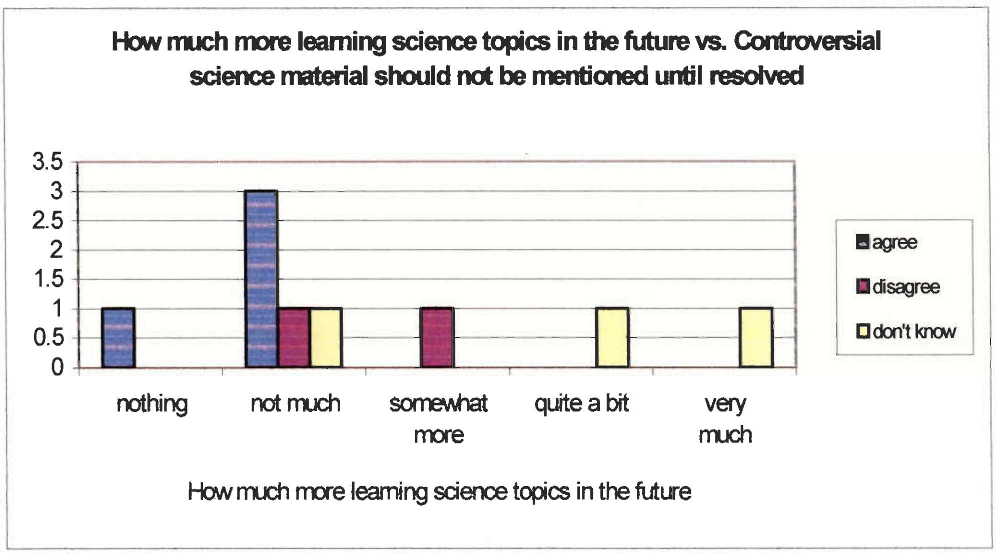


Table 4.5.10 on the next page further shows some significant correlations that were found when comparing whether students wanted a job using science material, the amount of effort they were putting into their science class right now, and their perceptions on science and scientists. A particularly interesting correlation that was observed from this table involved students who wanted to go to college and become a scientist/engineer and students who felt that controversial material that had not been resolved should be taught in science class (see Figure 4.5. 16 on the next page). As seen from the figure, of the 9 students who answered both questions on the survey, 67% (6 students) felt that it was not at all likely or not likely for them

to become a scientist or an engineer. Of these 6 students, 50% felt that controversial material should not be taught in science class, 17% felt that it should be, and 33% did not know.

Table 4.5.10

Significant Pearson Correlations (none less than .05 and 9 cases)

	Go to college and become scientist/ engineer	Controversial science material not mentioned until resolved	Effort in science class for an A?	Job using science material?	How much do you enjoy physical science?	Science is described as lively
Job using science material?	.866	-.587	--	--	--	--
Go to college and become scientist/ engineer	--	-.747	.758	.866	--	--
Controversial science material not mentioned until resolved	-.747	--	--	-.587	--	--
Science helps me learn to think more clearly	--	--	--	--	-.605	-.710

Figure 4.5.16

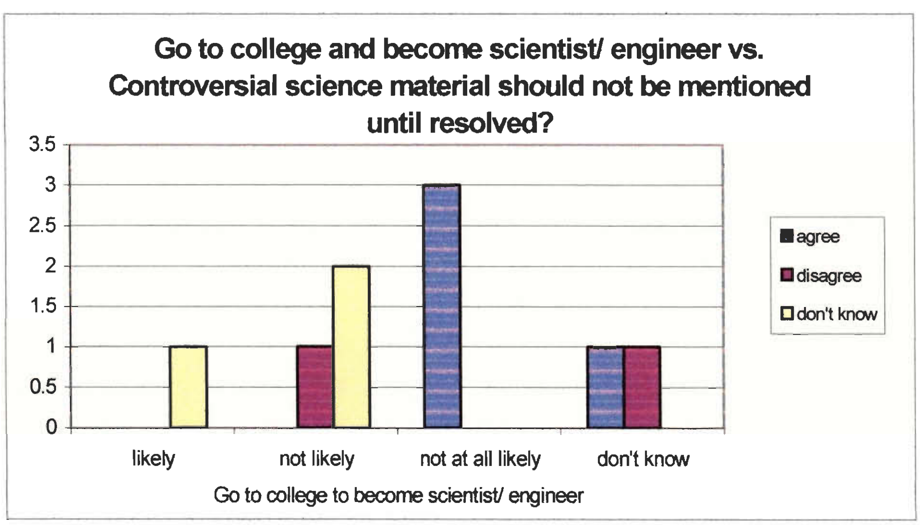


Table 4.5.11 below shows the significant correlations that arose when the question "benefits of science outweighs the disadvantages" was compared to questions that asked about the amount of effort students were putting into science class, whether science was important in their life and future. As seen from the table, there were some expected correlations (such as the negative correlation between how much students want to study health in the future and whether they enjoy health class) and unexpected correlations that were found (the negative correlation between how much effort students put into science class compared to the benefits of science).

Table 4.5.11
Significant Pearson Correlations (none less than .05 and 10 cases)

	Is science important to your life?	Importance of science to future schoolwork ?	Effort in science class for an A?	Intelligence in understandi ng science for job?	Science helps me learn to think more clearly	How much more learning health topics in the future?
Benefits of science outweigh disadvantag es	.687	.655	-.683	.658	.656	--
How much do you enjoy health science?	--	--	--	--	--	-.587

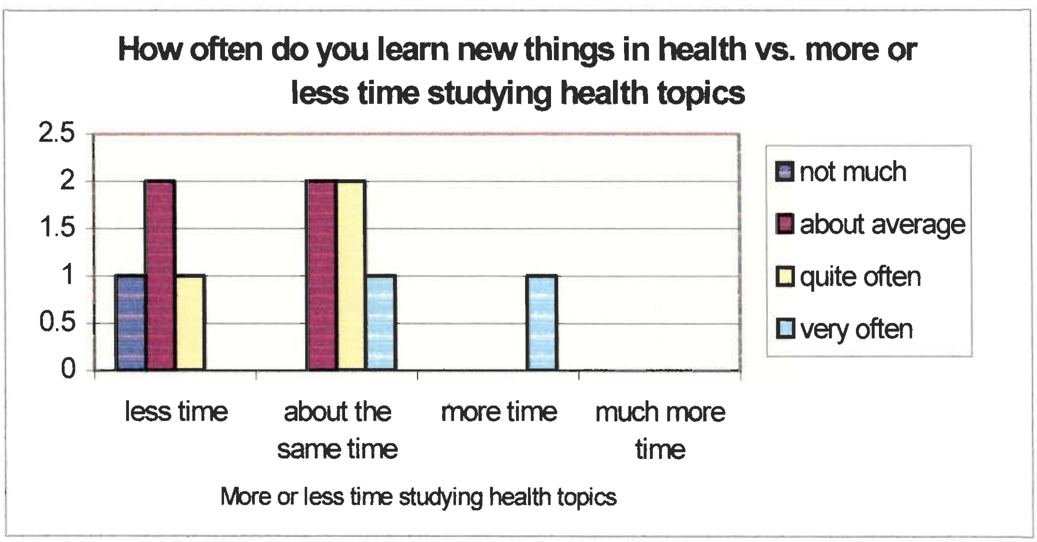
Table 4.5.12 on the next page shows further correlations that were observed upon analysis of the pre course evaluation. As seen, there is a positive correlation between how often students learn new things in health compared to whether they would like to spend more or less time studying health topics (please see Figure 4.5.17). As seen from the figure, 10 students answered both these questions, and 50% (5 students) wanted to spend the same amount of time

on studying health, and 40% of them (4 students) wanted to learn about new health topics "about average".

Table 4.5.12
Significant Pearson Correlations (none less than .05 and 10 cases)

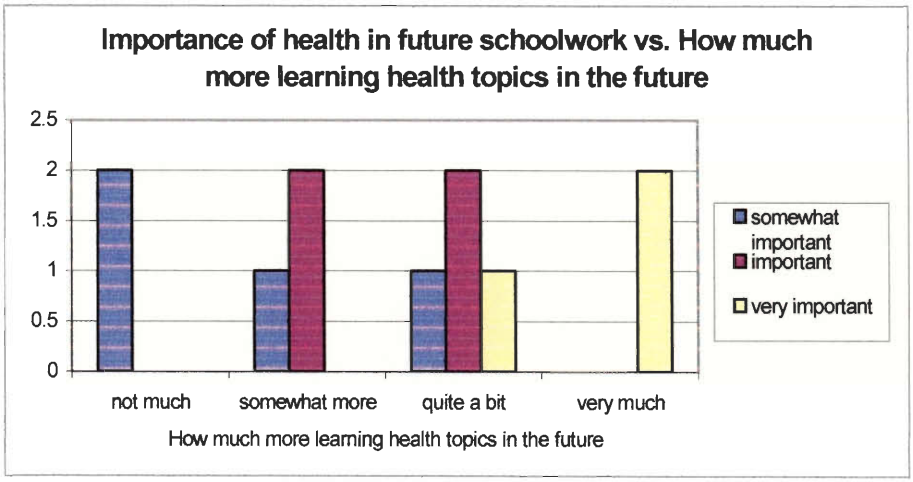
	More or less time studying health topic?	How much more learning health topics in the future?
How often do you learn new things in health?	.531	--
Importance of health in future schoolwork?	--	.760
More or less time studying health topic?	--	.567

Figure 4.5.17



Another correlation that was observed from the table above is between the importance of learning health topics for future schoolwork compared to how much students want to study health topics in the future (please see Figure 4.5.18). As seen from the figure, 11 students answered both questions on the survey, and 55% of the students (6 students) felt that learning health topics in the future was "quite a bit" or "very" important. Of these 6 students, 83% (5 students) felt that health was "important" or "very important" to future schoolwork.

Figure 4.5.18


Importance of health in future schoolwork vs. How much more learning health topics in the future
2.5
2
1.5
1
0.5
0
not much
somewhat more
quite a bit
very much
How much more learning health topics in the future
somewhat important
important
very important

In summary, there were many expected and unexpected correlations found when the pre course evaluation was analyzed, along with negative and positive correlations. For example, there is a negative correlation between whether a student is enjoying science class and the perceived importance of health in his/her life. It is not clear whether this is a lifestyle statement or merely suggests that the students do not have as high regard for health education as they do for science education. Also, there is no perceived relationship between the importance of health and science in schoolwork. They are not connected or considered equally important by this population. While there is a correlation between whether the student wants to spend more or less time studying health and science respectively, the students do not feel that science and health are intertwined subjects. There is even a negative correlation between whether science is considered important to a student's life and his/her likelihood of putting forth the effort in the class needed for an A. We think that typically the greater the effort a student puts forth in a class the more important the class is considered to be to his/her life and that the situation concerning health class is atypical. We note that the useful and controversial stuff is not what they are typically learning about, but the idea of addressing such material is appealing. Hence a strong case could be made for trying the STS approach in this setting. When the student does put forth the effort, they do not find that the science they are learning about in high school is the science that they are going to put to use in the real world.

There were also several expected reactions documented by the survey. The more beneficial the student considers science to be, the more important science is perceived to be in his/her life. Also, there were positive correlations between whether the students want to study more health topics in the future to which health is perceived to be important background for future schoolwork. The extent to which health topics are expected to appear in future studies is all a factor in attributing “importance” to them. If the students feel that health education is important, they expect to learn more health science in the future.

4.6: Post Course Evaluation

The post course evaluation was distributed to the 11 students in the North High School health class after the Backpack unit was completed. The purpose of the evaluation was to determine how much students enjoyed the backpack unit, whether they felt they had learned any mathematics and science during the lesson, which lessons they liked the best and worst, and whether they liked the S-STS style of teaching.

In general, while the students did not particularly like the unit, the majority liked the idea of learning science units in the same way the backpack and back pain unit was taught. Many of the students also enjoyed the creation of a backpack lesson because they were forced to think and let them be creative. One of the least popular lessons was the calculator lesson because the students felt that it was confusing and difficult. For the most part none of the students had seen a graphic calculator before and it was perhaps too much to expect the students to learn the calculators after only one day of instruction. There were not as many "I don't know" responses to the posed questions, making the data more reliable, useful, and revealing. There were also some short answer questions posed.

The post course survey (like the pre-course survey) had some remarkable results as can be seen in Table 4.6.1. At the end of the unit the students that felt health science was enjoyable did not feel that they did well in the unit as can be seen by the negative correlation in the table. The opposite was true. The student scores had actually increased a great deal especially for those most engaged in the material. However, even though the students' scores increased they did not believe that the information learned in this unit was important to their lives or those of their friends and family members. This is most likely explained by the fact that the unit was not the most relevant topic for the ninth to tenth grade age group. The lesson would be more important to students in grades six to eight.

Table 4.6.1

Significant Pearson Correlations (none worse than .05 and 11 cases)

	How much do you enjoy art/ drama/ dance?	How often did you learn new things in this unit?	Best describes your view of math:	How much do you enjoy physical science?	Do you think that science is related to math?	Do you think you did well in this class?	How important is the information about science and health in this unit to your daily life and the lives of your friends/family?
How much do you enjoy math?	-.620	-.579	.602	--	--	--	--
How much do you enjoy life science?	--	--	--	.734	--	--	--
How much do you enjoy physical science?	--	--	--	--	-.605	--	--
How much do you enjoy health science?	--	--	--	--	--	-.507	-.546

The table above shows that there is a negative correlation between how much students enjoy mathematics and how often they learned new things in the Backpack unit (please see Figure 4.6.1). As seen from the figure, 12 students answered both of these questions, and 50% of the students (6 students) felt that they learned new things in the unit "quite often" or "very often", 33% (4 students) felt they learned new things in the unit "about average" of the time. As seen from the figure, all of the students who liked mathematics (ranked it between 5-10) felt they learned "not much" or "about average" amount of new material in the Backpack unit, whereas those students who didn't like mathematics (ranked it between 1-5) felt they learned new things in the unit "quite often" or "very often". For the most part the more positive the student view on math, the less likely the student was to have leaned new things in the unit. The class did not feel that math was important and/or interesting. Since the calculator and data lessons were not that well received, the students' views on math were probably not improved by their experiences.

As seen from Table 4.6.1, there is a positive correlation between how students feel about mathematics and whether they enjoy mathematics (please see Figure 4.6.2). As seen from the figure, 11 students responded to both these questions, and 73% (8 students) felt that mathematics was important but not interesting and 18% (2 students) felt that mathematics was both interesting and important. Of the 6 students who felt they liked mathematics (ranked it between 5-10), 67% (4 students) felt it was important but not interesting while 33% (2 students) felt it was important and interesting.

The table above also shows that there is a negative correlation between how much students enjoy health class and whether they felt the information learned in this unit was important (please see Figure 4.6.3 on the next page). As seen from the figure, 12 students responded to both of these questions, and 50% (6 students) of the class enjoyed health (ranked health between 5 and 10 on the scale). Of these 6 students, 33% felt the information learned in this lesson was not important to them and 50% felt that it was important. In contrast, 100% of the students who stated they did not like health felt the information in the unit was important to them and their family.

Figure 4.6.1

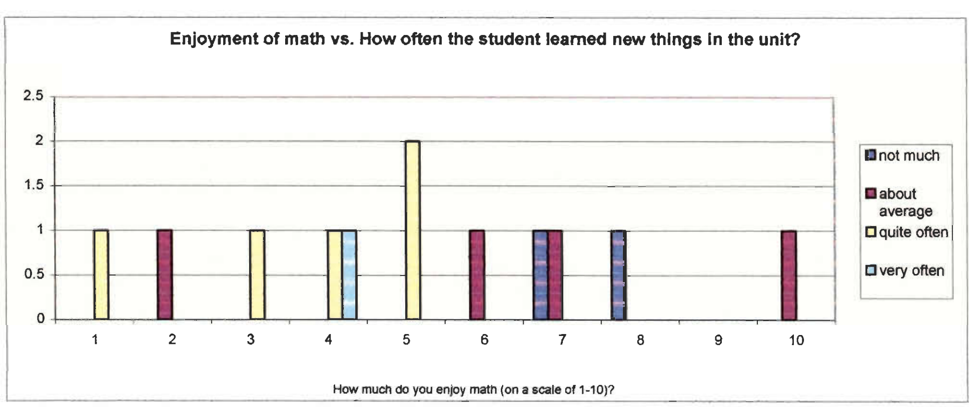


Figure 4.6.2

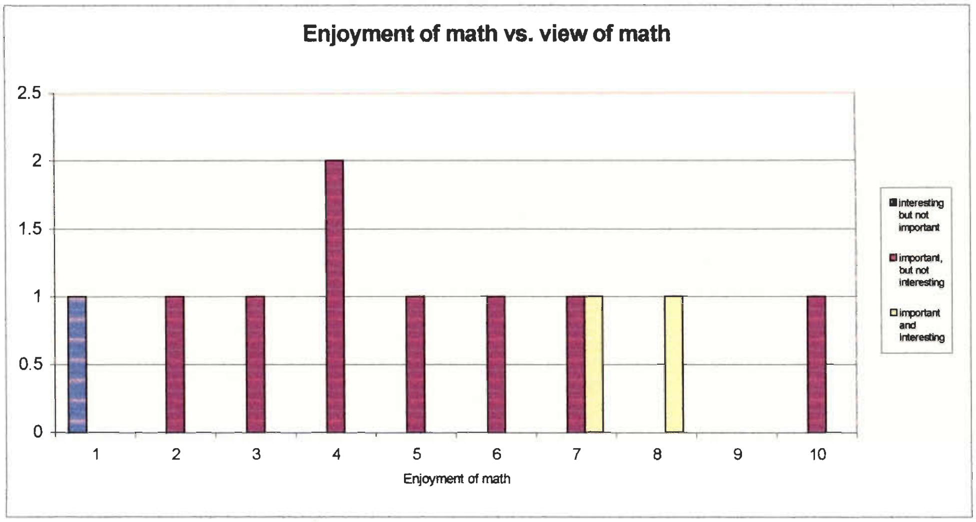


Figure 4.6.3

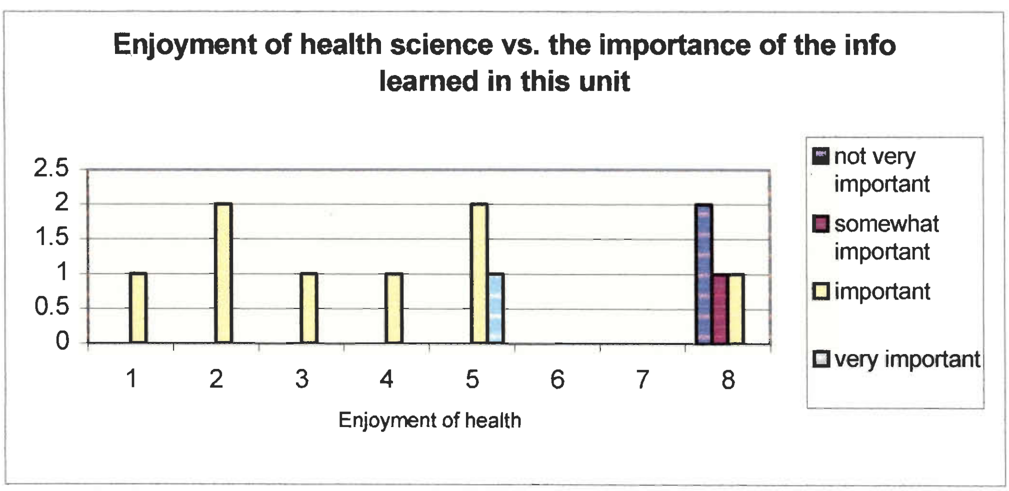


Table 4.6.2 below gives some more significant correlations that were found by analyzing the post course evaluation. As seen from the table, there is a negative correlation between how often students learned new things in the unit and their view on mathematics (please see Figure 4.6.4). As seen from the figure, of the 11 students who answered both of these questions, 45% (5 students) felt they learned new material in the unit "quite often" or

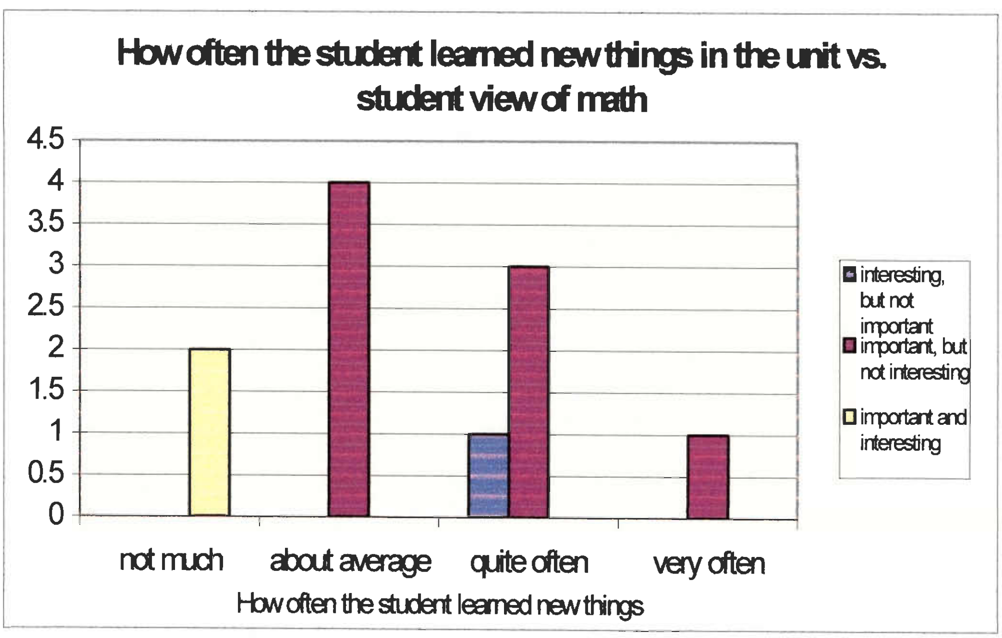
“very often”, and these 5 students, 80% (4 students) felt that mathematics was important but not interesting and 1 student felt that mathematics was interesting but not important. Two students that felt math was both interesting and important, and both of these students felt they had not learned new things in the Backpack unit very often.

Table 4.6.2

Significant Pearson Correlations (none worse than .05 and 11 cases)

	If it were up to you, would you spend more or less time studying the topics of this unit?	If it were up to you would you spend the whole year?	How likely is it that you will go to college and study to become an engineer or scientist?	Best describes your view of math:	Do you think science is related to math?
How much do you enjoy computer science?	-.623	-.539	--	--	--
How often did you learn new things in this unit?	--	--	.502	-.675	.547

Figure 4.6.4



Another interesting correlation that was observed in Table 4.6.2 above is between whether students feel that science is related to math and whether they learned new things in the unit (they should have learned that science was related to mathematics in the unit). As seen from Figure 4.6.5 below), of the 11 students who answered both questions, 73% of the students (8 students) strongly agreed or agreed that science is related to mathematics. Of these 8 students, 50% (4 students) learned new thing in the Backpack unit quite often and 25% (2 students) felt they didn't learn much new material in the unit. Out of all 11 students, only 18% felt that science was not related to math.

Figure 4.6.5

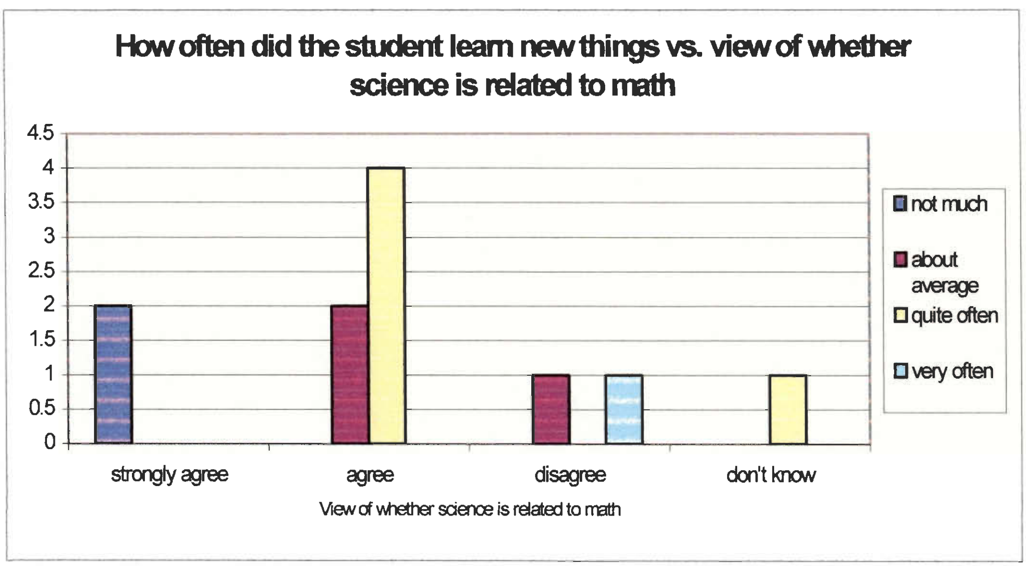


Table 4.6.3 on the next page further shows some significant correlations that were found when analyzing the survey. As seen from the table, a positive development was that the students' effort in the unit was correlated with the perceived importance of the unit (please see Figure 4.6.6). In addition, the students' interest in the unit was linked with the effort they put forth (please see Figure 4.6.7). It was expected that the more interesting the topic the more

effort the students would put forth. The students were fairly evenly split on the importance of this unit to their future schoolwork and their interest in the unit. These students were also fairly evenly split on how they would like to learn science in the future. However ,all but two of the students expressed some interest in the unit.

Table 4.6.3
Significant Pearson Correlations (none worse than .05 and 11 cases)

	How important is the information about science and health in this unit to your daily life and the lives of your friends/family?	If it were up to you, would you spend more or less time studying the topics of this unit?	How interesting did you find the Backpack and Back Pain Unit?	Math helps me to learn how to think more clearly.	How would you compare the four weeks spent studying backpacks and back pain to other science subjects you have studied this year?
How much effort did you put in to this unit compared to your usual health class?	.570	.598	.687	-.564	-.540

Figure 4.6.6

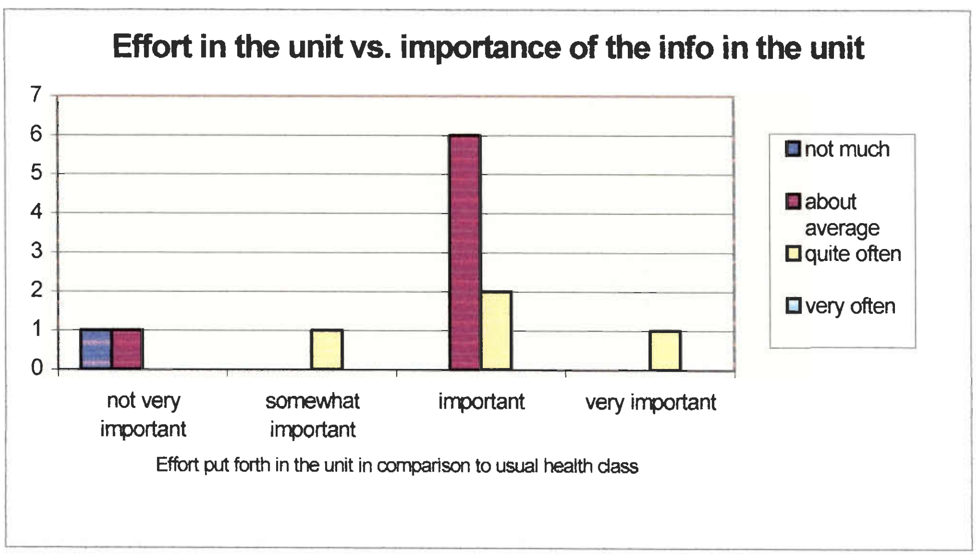


Figure 4.7.7

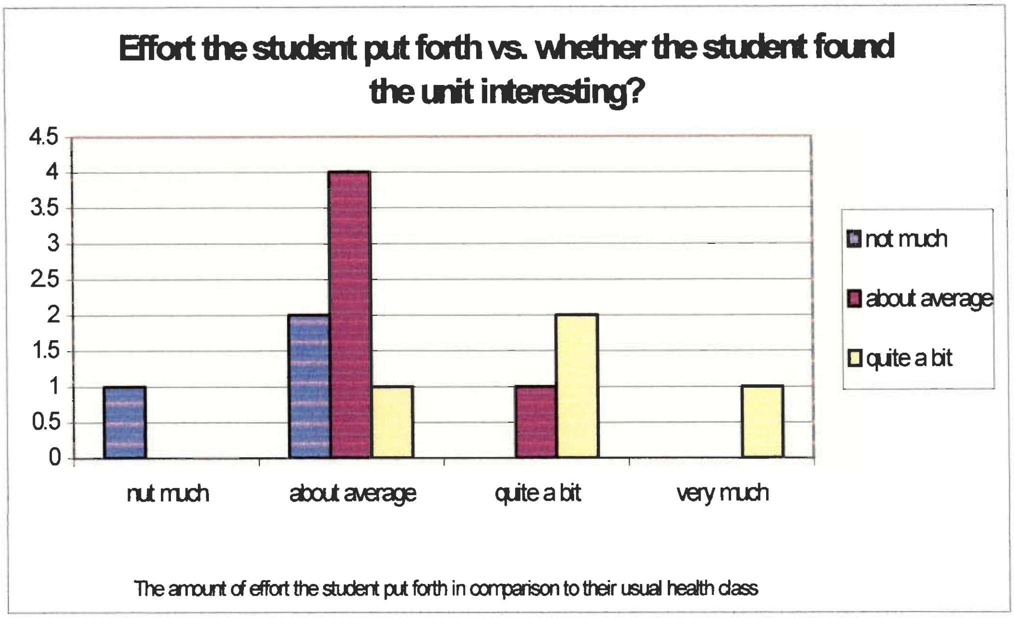


Table 4.6.4 on the next page shows the significant correlations that were found when students interest in the backpack unit was compared against their perceptions on science and mathematics. As seen, there were a couple of expected relationships. The more important the student felt the unit was, more interesting the student found the unit (see Figure 4.6.8 on the next page). Also the more interesting the student found the unit, the more likely the student wanted to spend more time on the unit. There was also a relationship between the effort the students put forth and how interesting other science topics studied were (see Figure 4.6.9 and Figure 4.6.10 on the next page). This unit was more scientific than health related. Thus if the students enjoyed their science classes they were more likely to enjoy our unit.

Table 4.6.4
Significant Pearson Correlations (none worse than .05 and 11 cases)

	How interesting did you find the Backpack and Back Pain Unit?	Do you think that Science is related to math?	Math helps me learn how to think more clearly.	If it were up to you, would you spend the whole year:	How would you compare the four weeks spent studying backpacks and back pain to other science subjects you have studied this year?
How important will the info learned in this unit be to your future school work?	.584	.677	--	--	--
If it were up to you would you spend more or less time studying the topics of this unit?	.587	--	-.674	--	--
How interesting did you find the Backpack and Back Pain Unit?	--	--	--	-.538	-.836

As seen from Figure 4.6.8 below, 12 students answered both of the following questions: "importance of the unit to future school work" and "student's interest in the unit". Fifty percent (6 students) of the class felt that the Backpack unit was "important" or "very important" to their future schoolwork. Four students out of 12 (33%) were "quite a bit" interested in the backpack unit, and 42% (5 students) had "about average" interest in the unit. Of the six students that felt the backpack unit was important or very important to future schoolwork, 50% felt that they were "quite a bit" interested in the backpack unit and the remaining had about average interest in the unit. Two students felt that the Backpack unit was not very important to their future school work, and both of these students had "not much" interest in the unit itself.

Figure 4.6.8

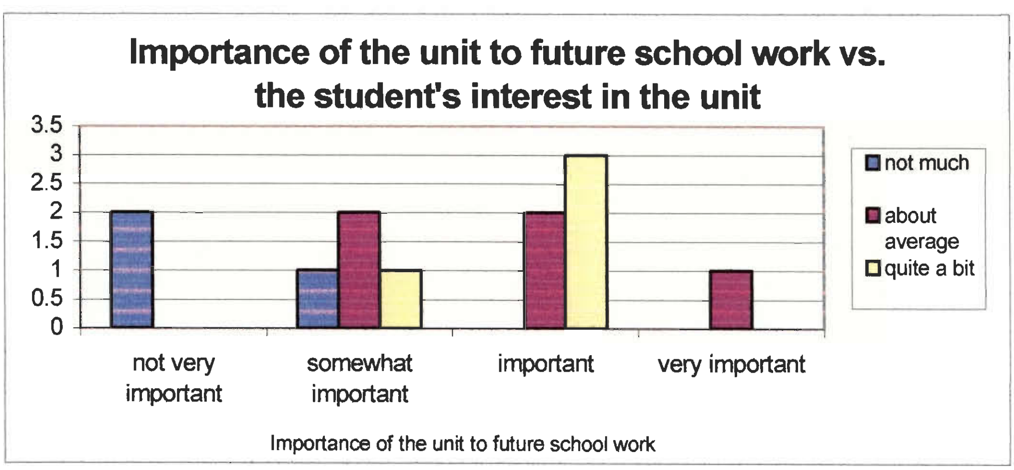


Figure 4.6.9 below further explores the correlation between student's interest in the Backpack unit compared to whether they would like to learn about science topics in the S-STS format in the future. As seen, of the 12 students who answered both questions, 42% (5 students) would like to learn science topics in the S-STS format in the future. Four out of 12 students (33%) had quite a bit of interest in the Backpack unit, and 74% of these students were in favor of learning science topics in the S-STS format in the future. Five of the 12 students (42%) had "about average" interest in the unit, and 80% of them wanted to learn science in the S-STS format in the future. Two students did not have much interest in the unit, and both wanted to learn science in the traditional way.

Figure 4.6.9

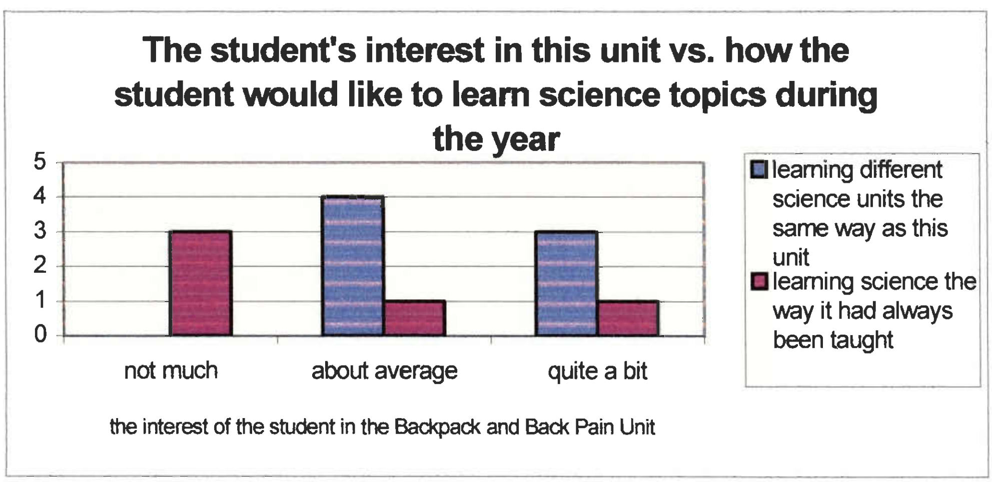


Table 4.6.4 also shows there is a significant correlation between how much effort students put into this unit compared to their interest in the unit versus other science topics studied (see Figure 4.6.10 on the next page). As seen from the figure, of the 12 students who answered both questions, 33% (4 students) put forth much better or slightly better effort compared to their health class, 42% (5 students) put forth about average effort compared to

their health class, and 25% (3 students) put forth slightly less effort. Of the 12 students, 33% (4 students) had "quite a bit" or "very much" interest in the unit, while 58% had about average interest in the unit.

Figure 4.6.10

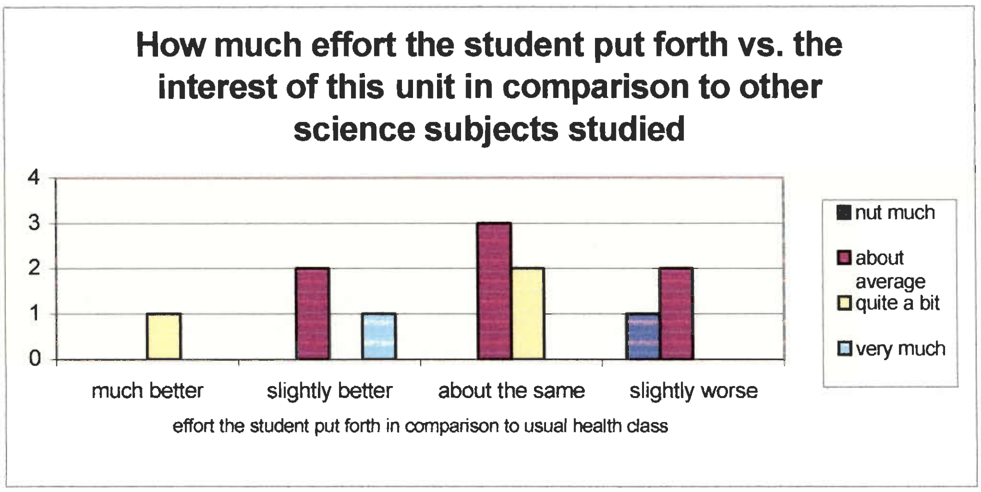


Figure 4.6.11 below shows the significant correlation between students interest in this unit compared to other science subjects. As seen of the 12 students who answered both of these questions, 33% (4 students) had slightly better or much better interest in the backpack unit compared to other science subjects and 42% (5 students) had about the same interest. All of the students who didn't have much interest in the backpack unit felt that the backpack unit was slightly worse than other science subjects they had studied. All of the students who felt the backpack unit was much better than other science subjects enjoyed the unit "quite a bit".

Figure 4.6.11

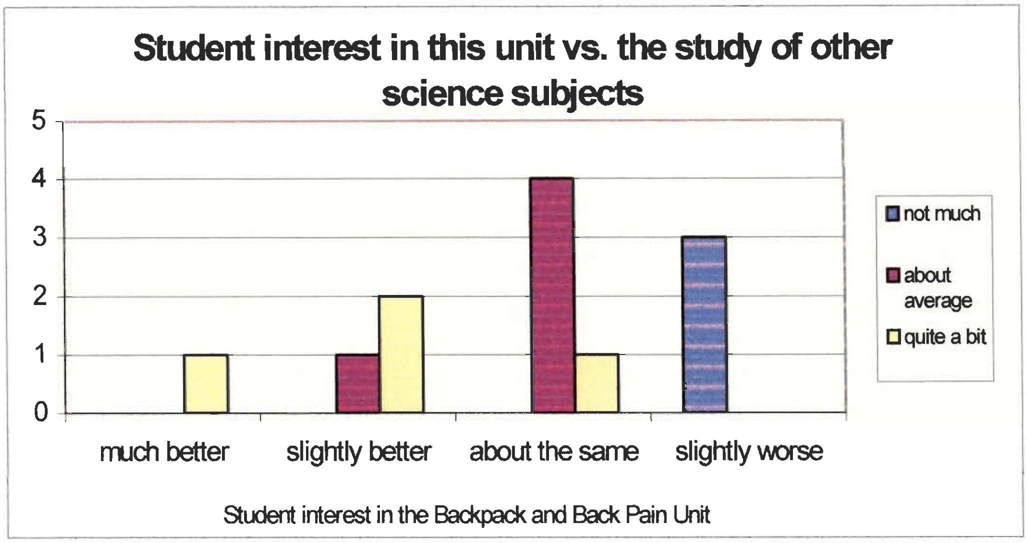


Table 4.6.5 below gives some more significant correlations that were observed when comparing students' views of math and science to whether they would like to study both of these subjects further. A significant correlation that is observed in this table is between students view of science compared to their view on math (please see Figure 4.6.12). As seen in the figure, of the 11 students who answered both of these questions, 73% (8 students) felt that math was important but not interesting while 36% (4 students) felt that science was important but not interesting.

Table 4.6.5
Significant Pearson Correlations (none worse than .05 and 11 cases)

	Best describes your view of math:	Science helps me learn how to think more clearly.	If it were up to you would you spend the whole year:
Best describes your view of science:	.555	-.621	--
How would you compare the four weeks spent studying backpacks and back pain to other science subjects you have studied this year?	--	--	.534

Figure 4.6.12

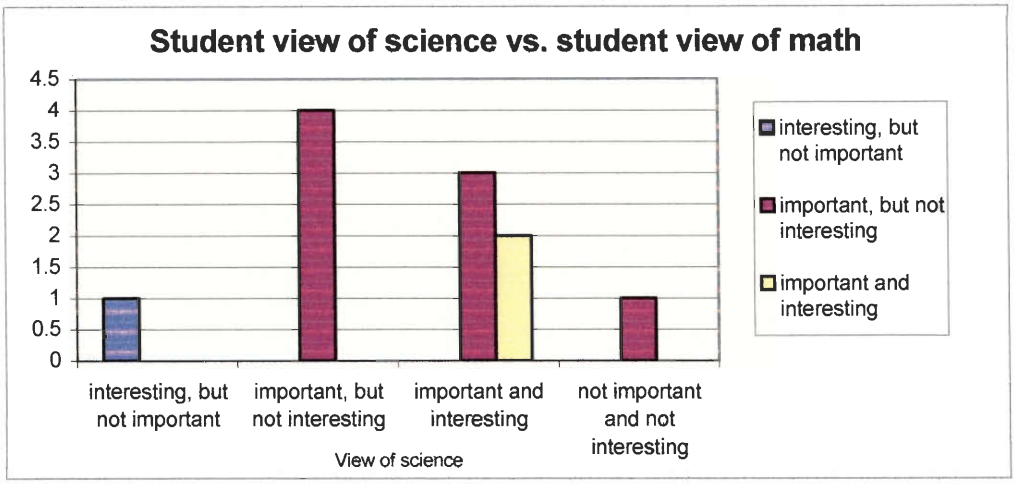


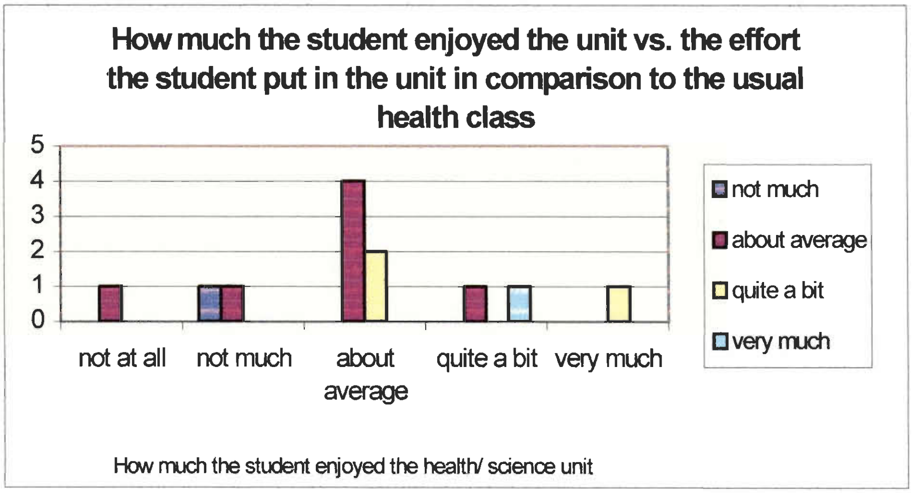
Table 4.6.6 below shows the significant correlations that arise when how much students enjoy health class is compared to how much effort they put into the unit and how important they perceive the information in the unit to be. Figure 4.6.13 below explores the correlation between how much students enjoyed the unit and how much effort they put into the unit compared to their usual health class.

Table 4.6.6

Significant Pearson Correlations (none worse than .05 and 11 cases)

	How much effort did you put into this unit compared to your usual health class?	How important is the info about science and health in this unit to your daily life and the lives of your friends/family?	If it were up to you would you, would you spend more or less time studying the topics of this unit	If it were up to you would you spend the whole year:	How would you compare the four weeks spent studying backpacks and back pain to other science subjects you have studied this year?
How much did you enjoy this health/science unit?	.559	.686	.535	-.507	-.928

Figure 4.6.13


How much the student enjoyed the unit vs. the effort the student put in the unit in comparison to the usual health class
5
4
3
2
1
0
not at all
not much
about average
quite a bit
very much
not much
about average
quite a bit
very much
How much the student enjoyed the health/ science unit

4.7: Social Awareness Survey

As previously mentioned in Section 3.1, a social awareness survey was conducted at North High School to see if there was a conscious raising movement amongst the students in the school. In order to do this, a survey was distributed both before and after the unit was taught (please see Appendix B) to judge if there was a shift in interest regarding health topics and heavy backpacks amongst the teenagers.

Unfortunately, the results of this survey were not able to be analyzed due to errors that occurred during data collection. While the survey was able to be distributed to 25 9th, 10th, 11th, and 12th grade students respectively before the unit was administered, the same was not so after the unit was taught. Since the backpack unit ended on the last week of school, 12th grade students had already graduated, and very few 10th and 11th grade students were attending classes. Therefore, the data from these three grades could not be obtained after the unit was taught, and the number of 9th graders surveyed was significantly lower from when the survey was administered before the unit.

Due to our inability to properly administer the survey after the unit was taught, it was decided that analysis of the existing data would be meaningless with nothing to compare. Our hypothesis remains that a conscious raising effort stemming from a group of 11 students would be difficult to accomplish, especially since we are trying to "conscious raise" the wrong age group.

4.8: Summary of Results

Pre and Post Course Evaluations

While students knew what scoliosis was by the end of the four-week curriculum, the lessons on scoliosis treatment and the scoliosis debate were less well received. The majority of the students did not retain much of what they were told about the treatment and the controversy surrounding the screening of the school population to detect this relatively rare condition. The average score received for each of these questions was right around half of the total available points. Prior to the course the students that were able to provide some additional information about scoliosis (other than recognizing it and knowing that it is a name of a disease) barely touched upon these topics, so this topic was new to the class. The whole class was starting from scratch in preparing for this part of the exam. Three students learned absolutely nothing about one or the other of these questions and got a score of zero that brought down the average. Most of the rest got partial credit. Few gained a full understanding of the treatment of scoliosis and the logic of the ongoing debate about screening for it in school. All of the students learned the definition of scoliosis, three students gained an extensive knowledge of treatment for scoliosis, and one student was able to accurately identify the cause for the scoliosis debate.

There were a few topics that were only addressed by one of the course measures. Some students did not even attempt the short answer or essay questions posed prior to the course. Some of these questions were pretty general too. Prior to the course, students were asked to identify what a hypothesis, control and experiment were and even that did not go well. There were also specifics that we did not expect them to know, but were being careful as part of the experimental design to be sure that it was not previously covered. Items asking them to describe the short term and long-term affects of carrying a heavy backpack on only one shoulder fell into that category. The average points earned overall was about four out of ten, so most of them were able to say something reasonable for their general background. However, four students actually earned zero points on this question. There is no way to know if the students even attempted these questions. Only two students attempted the final essay question about vitamins and minerals, which we considered sort of a gift—a common knowledge item (especially since the unit prior was on vitamins and minerals). For the questions on vitamins and minerals, and on backpacks some of the students who did not answer might have had some knowledge of the topic but we doubt it. The students were not willing to try to convey, but we view them as having had a first exposure to these topics in our class. The only question that was asked on the post course evaluation that was not asked on the pre course dealt with the common exercises that physicians recommend that a person with given back conditions should avoid and descriptions of two of the five exercises. That was so course specific it seemed a good indicator of attentiveness even without a pretest on that section. Five students received full credit and another two received partial credit on this item.

Students had more riding on the post course than the pre course measures as they were graded, so blank responses were very rare. The post course test was to count towards one of their essays that they were required to write in order to pass their class. Therefore, the students put forth more effort than they did for the pre course evaluation. Overall though, the students responded well to the STS-S curriculum concept and there is no reason to believe that a widespread pattern of holding back on the pretest inflated our estimate of how much content was learned in this unit. There was the strong increase in the students' scores even when they were expected to answer more difficult questions. Indeed if there is a bias it runs the other way. We did not ask exactly the same question pre and post in most cases. We covered the same issue, but the pre items seemed too simple to be a worthy exam after the unit so the post test items are more difficult and ask for specifics and details recently covered. This methodological complication seemed necessary to avoid over testing the class. The post measure had to serve both purposes, grading and assessing the overall gain.

North High Backpack Survey:

The North High backpack survey study was flawed for many reasons, but was the best we could do at the time. The students in the North High health class were asked to get some younger students to fill out the backpack survey. It was assumed that the students had younger siblings or neighbors that they could get to fill out the survey. For the most part that was not what they did. Only a few surveys were received from younger students for whom the questions were appropriate. The students were allowed to fill out the survey themselves when they stated that they did not have access to younger students. In addition, one of the students was allowed to give a batch of surveys to one of her classes. Thus, the survey was administered to the wrong sample. It also appeared that the students did not want to finish the surveys when they got home. This being the case, only a handful of students that actually weighed themselves and their backpacks. Hence, the pretest study they conducted was not going to produce useful data. It could only elicit comment on the items used and overall time involved in its administration, sort of a pilot study.

Another large problem was that this exercise was not controlled at the point of data collection. Even if the students entered their weight and the weight of their backpack, the weights were obtained at home. Therefore, the weights were each obtained on different scales and there was not a separate person recording the weights, while the participant was weighed.

Yet another problem was that the students were not interested in the study due to the student culture at the high school. For the most part the students did not carry backpacks. If they did carry backpacks, they only carried one or two books at a time and thus backpack weight was not a problem for them. The ages of the students were also outside the time frame given by the experts being the ages when students were most at risk. We wanted a late elementary to early middle school study group as that is the age group which would find the topic to be personally relevant.

Every student is required to take this health course in order to graduate. Hence, the students of the class were not the most dedicated students for the most part and were from different academic levels. Prior to the Backpack unit not much was required of them in health class. They were hardly ever assigned homework, but they were required to write several essays throughout the year and they did have tests. They considered it an imposition when we asked the students to fill out a seven-page survey and even to get other people to fill out the survey. Also, since the students did not have much personal concern about the theme, they did not put a lot of effort into it. Thus, the survey was a flop though we did estimate how extensive the problem was in the area served by the school through the larger experience of conducting the survey.

Worcester East Middle Backpack Survey:

The younger students at Worcester East Middle School (who are headed to North High in a year or two) were much more receptive to the survey than the students at North High School. The students were thrilled to fill out the survey and get their backpack weights measured and were generally very interested in the results. All of the surveys were filled out during class time (in one instance a class did not have enough time to finish the survey, but in that case only a handful were not able to fill out most of the survey). The students were supervised at all times when filling out the survey and we were available to answer any questions that the students had about the survey. In addition, the weights and height were primarily obtained in the Worcester East Middle's health room on an accurate scale in the Nurse's office though in a few instances on a single bathroom scale that was brought in to reduce the backlog of students waiting.

The students were probably interested in the survey because they were in the age group that experts say are most at risk for excessive backpack weight. An interesting finding of the survey was that a great deal more students thought there was a problem with the weight of their backpack than was actually the case. The average score of the students' response to the question, "Do you feel your backpack is:" was 1.87. The response of "too heavy too be carried comfortably most of the time" carried a value of one, the response, "too heavy to be carried comfortably some of the time" had a value of two, and the response of "not a problem to carry" had a value of three. The number of students who responded with each possible response was 32, 40, and 21 respectively. Hence about a third of the students thought they were probably at risk. However, the data showed that 25% of them were actually lugging more than 15% of their body weight that day, with most of those being in an honor's class. It is possible that the length of time that the students are carrying their backpack or how they carry it are more important determinations of whether they will get back pain than the experts expect. Since they would not anticipate a problem at the weight levels a number of students reporting pain were covered. Another possibility is that the experts over-inflated the recommended proportion of backpack weight to body weight of the students in an effort to try to be reasonable—identifying only those clearly at risk. Others seem to be hurting.

All of the teachers were supplied with the data from the survey. However it appeared that the teachers did not immediately feed the data back to their students. This could just be because they were waiting to reach a point in the course where the data would tie in nicely or they had already covered the unit that they would have used the data for. While it appeared that the teachers did not systematically share the results of the survey with all the students who participated, we attended a college night at Worcester East Middle and were able to share the results with a few of the students who had participated. In addition, there were several interested parents that looked over the results, asked questions, and in general got in to discussions with us. We are convinced that the subject is of interest to the younger audience and is a "relevant" thematic for an STS unit at the 5th- 8th grade level, the major group at risk of carrying more than 15% of their body weight.

Pre Course Survey

In addition to the pretest of course related knowledge we administered a survey of attitudes used as part of the typical STS unit evaluation process by prior WPI students. This led to logistical problems. Normally the survey is administered by itself. Our attempt to do it after the knowledge assessment created a time crunch. Hence, most people need another 15-20 minutes to finish and were requested to finish up as homework. Unfortunately, health class was not a "homework" kind of course. Instead of spending the twenty minutes to finish answering the survey, they would answer, "I don't know" when given the opportunity in an effort to finish in class. In many instances a third to over half the class had answered, "I don't know" to given items making further analysis of these questions moot. In addition many of these questions were designed to be analyzed with reference to other questions, some of which were in the post course survey. Thus, further analysis of questions concerning "benefits of science outweigh disadvantage", "controversial science material not mentioned until resolved", and "science helps me learn to think more clearly" was constrained and even if correlations with other questions appeared they would be suspect due to sample size.

Another problem was the shear volume of questions in the survey. We had to pick and choose which questions to correlate and then from there, which questions to use in cross tabulations. For the other surveys and questionnaires we correlated all of the questions and then pick and choose the questions to cross tabulate. It is possible that we missed a few questions that were correlated when it was not expected that they would be and we also could have missed questions that were not correlated even though we had expected them to be so (but the latter error is less likely).

Despite the above complications, the students warmed to the STS-S curriculum approach even though they were not particularly fond of the theme of our unit. Despite the fact that this unit was taught to a less than ideal class and age group, the students learned a great deal as shown in the results of the pre and post course exams. In addition, many students enjoyed several of the features associated with STS-S curricula based on the results of the post course survey. The Pre-Course survey results were suspect for the reasons stated above, but we avoided the logistical logjam at the end of the course and have some faith in those results, so they will be emphasized in the interpretation.

Post Course Survey

While the students did not particularly enjoy the Backpack and Back Pain Unit, they endorsed the idea of socially contexted science as illustrated by the STS-S curriculum unit. Six of the twelve students that answered the post course survey reported that they preferred to learn science this way and would like to see more units taught in the same contexted way as the unit at hand. We suspected that if it were not for some of our shortcomings as instructors, more students would have preferred the style in which the unit was taught. We had little or no experience teaching and we were not as well prepared to teach a class as we thought we were. We were surprised by the difficulty and time involved in preparing a unit for the students. Another fault of ours was that we were not sure of the level of difficulty appropriate for the students. We prepared lessons that we thought that the students should have been able to grasp in high school, when in fact they had difficulty with them and had not had prior exposure to key concepts. We were a little too ambitious concerning what to expect from the students for the time allotted as a general rule. Hence, from the student perspective we expected a lot, wanted them to work at home, and changed the prevailing standards.

A big complaint of the students was our difficulty in communicating and explaining exactly what we wanted from them. Several times we were asked to clarify instructions and often we had to change the lessons on the fly due to the difficulty the students were having with understanding the material. One student reported that he would have preferred it if there were more fun activities to do. Four of the ten students who supplied an answer to the question about their favorite activity enjoyed the lesson where they designed their own backpack. They enjoyed being encouraged to "think" originally and this lesson allowed the students to be creative. Two students enjoyed the muscles and bones lesson the most because they were "different" and two preferred the scoliosis lessons because it was a topic that was familiar to them (one of those students had scoliosis).

By far, the least popular lesson was the calculator lesson. The reasons for the students' disliking it ranged from the lesson being confusing and difficult to not enjoying math in general. The second least appreciated lesson was when the students had to do the surveys. In an ideal world the students would have been exposed to graphing calculators during middle school and at worse during algebra class in high school. However, for the most part these students had never seen a graphing calculator prior to their exposure to them during the unit. It was too much to expect the students to grasp even the basic functions on the calculator in one class. It would have been better if they had a week or two to become familiar with the calculators and to perhaps have had a math teacher assisting us.

Clearly this was not the best group to be doing the unit with, as it was not coming to the unit with the expected background. As stated before, hardly any of the students carried backpacks and so the main topic of the unit was not as important to them as if the unit had been taught in middle school. Dealing with fifth to seventh graders we would not have expected so much math background and might have hit a better balance with their background. The students also refused to put much more than the average work effort into the unit though the class as taught included more difficult material than usual for health class. That was new to them. The students were being asked to meet a higher standard than usual in their health class and resisted to the idea. It would also have been better if the unit had been taught in a more advanced class and perhaps even in a science class, but there was no room in that curriculum for more content, or so we were told.

The class as a whole reported only average enjoyment of the health/ science unit. They also had only an "average" interest in the topics of the unit. The class as a whole did not have a strong reaction to the unit due to its thematic—not a plus, but also not a negative. It did not matter to them whether they spent more or less time on the Backpack and Back Pain Unit (the average score was 2.67 with 3.0 being average). The students also compared the unit to other science subjects studied during the year as "about the same" (the class had an average score of 2.83 with 3.0 being about the same). A more experienced instructor with a good idea of where the class is at the outset will probably be instructing the students if the unit is taught again. In a more appropriate setting, and with some of the logistical kinks worked out, the unit promises to be quite successful. We will remove the major stumbling block—production of a good data set to use in the statistical part of the unit. Given a pre-existing data set the results can be preprocessed to a point appropriate to the goals of the class, ranging from table interpretation to the processing of raw data. The overall approach has shown enough promise in this pilot field test for us to be comfortable making that no doubt investment.

Chapter 5: Conclusion

Worcester Polytechnic Institute has been devoted to the development and evaluation of S-STS curricula that have used various thematics such as acid rain, water pollution, ozone, et cetera for several years now with relative success. However, it is peculiar to note that the two S-STS curricula that have used health thematics as the social issue, the Skin Cancer Unit by Atkins and Roberts and the Alzheimer's Unit by Dang, Hoang, and Nguyen, have not been as successful as other units developed at W.P.I. The goal of this project was to determine if a successful S-STS unit using a health thematic could be developed and field tested, with success being measured by students' reaction, participation, and performance on the unit, which was evaluated via observance, examinations, and evaluations.

The social issue that was used in developing this unit was the heavy weight of backpacks that students carry, especially in the 5^{th}-8^{th} grades. The heavy weight of backpacks is rapidly becoming a national concerns for physicians, parents, and students, as an increasing number of students are complaining of chronic backache and posture problems. Since this social issue was of direct relevance to the students' lives (and a problem they encountered on a daily basis), it was anticipated that the unit would be better received by the students as opposed to the skin cancer and Alzheimer's units (since cancer and Alzheimer's are conditions that will affect students when they are much older). Although the issue was not as "snazzy" as cancer and Alzheimer's, it also avoided the "dread disease" issue, which was thought to have been the major obstacle in the success of the skin cancer and Alzheimer's units.

Due to the MCAS examinations, which have become a widespread concern for public school officials in Massachusetts (more than 75% of the students are at risk of failing this examination), it has been increasingly difficult to gain permission for W.P.I. students to field test units. For this reason, the Backpack unit was unable to be field tested in the ideal setting (a 5th-8th grade classroom), and instead was taught in a health class consisting of 9th-10th grade students. The class was mandatory and had no core curriculum, henceforth there was an extremely relaxed atmosphere and not much pressure on the students of this class. Students described the health classroom as an "easy A", a class where they did not have to do much work and expectations were low. The Backpack unit changed the dynamics of the class. Suddenly, students were learned "serious" science such as physics and anatomy and mathematics, and the relaxed atmosphere changed as students were given homework and class work on a daily basis.

Despite the aforementioned problems, the results obtained from in this evaluation have been very encouraging for further use and study of health issues in S-STS curricula and seem to indicate that the "dread disease" issue was indeed the impediment in the success of health topics as thematics in S-STS units. Although students at North High School didn't particularly relate to the backpack problem and many of the students didn't enjoy the Backpack unit, all of the students in the class learned the material taught in the unit. The scores on the examination that was administered both before and after the unit showed a marked increase in knowledge in subjects such as nutrition, scoliosis, anatomy, physics, and mathematics. In addition, students enjoyed the concept of an S-STS curricula, where all subjects are intertwined and taught on a "need to know" basis. The mathematics lesson was not very well received by the class, perhaps due to the biased and incomplete database that was obtained by the students, but this has been remedied by collecting a nonbiased and extensive database from the correct study group at Worcester East Middle School.

In addition to the promising results obtained from examinations and evaluations, it was also observed that the Backpack unit drew the quite and shy students in the class into discussion. At the beginning of the unit, the majority of the class was reluctant to participate in class discussions, and towards the end of the class these very students were leading debates in the classroom. Students' confidence in public speaking increased markedly.

In conclusion, it can be stated that the Backpack unit shows considerable promise. When the social issue was presented to students at Worcester East Middle School (7^{th}-8^{th} graders), students were extremely enthusiastic and whole heartedly identified with the problem. It is anticipated that future testing of this unit in an appropriate setting, a 6^{th}-8^{th} grade science classroom, will yield great success and overcome the stumbling blocks present in this field test (such as students identifying with the unit and the mathematics lesson).

Bibliography

1) Alderson, Jeffrey. A Standard Evaluation of WPI STS Curricula. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1997

2) Alexander, Charlotte. "Of Course it's Heavy: It's my Backpack" U.S. News and World Report 127 (1999): 70

3) Atkins, Corena, and Roberts, Jeffrey. Tans Aren't So Healthy Anymore. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1997

4) Bella, Lionel M., and Erin, R.L. Evaluation of 6th Grade S-STS and Traditional Modules Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1994

5) Brown, Richard, G. Advanced Mathematics. Boston: Houghton Mifflin Company, 1992

6) Conn, Bevin. "Packing it in" Women's Sports and Fitness. 19 (1997): 76

7) Dang, Quynh, Hoang Long, and Nguyen Que. The Long Goodbye: An 11th Grade Biology Curriculum Module. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1996

8) Giancoli, Douglas, C. Physics: Fourth Edition. New Jersey: Prentice Hall Incorporated, 1995

9) Gunnan and Klevens. Power Line Safety Study. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1996

10) Hogan, Richard W. and Reagan, M.E. Response to S-STS Curriculum: Comparative Study of ChemCom" Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1991

11) Miller, Stephen A., and Harley, John B. Zoology: Fourth Edition. New York: The McGraw-Hill Companies Incorporated, 1999

12) Modderno, Jeffrey and Tonning, Bob. The Quabbin Story: an S-STS Curriculum. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1994

13) Negrini, S. "Operation Overload: Kids' Backpacks" Science News. 157 (2000): 31

14) Negrini, Stefano, Carabalona, R., and Sibilla, P. "Backpack as a Daily Load for Schoolchildren" The Lancet. 354 (1999): 1974

15) Purcell, Shelia. "It's in the Bag" Times Educational Supplement. 4292 (1998): D6.

16) Syrigos, Yianni and Keagle, Brian. A Review of the WPI Sixth Grade Science Through S.T.S. Curriculum Project. Worcester, MA: Worcester Polytechnic Institute I.Q.P. Report, 1994

17) Teare, Tracy. "Packing it in" Women's Sports and Fitness. 19 (1997): 76

18) Yager, Robert E. "The Advantages of STS Approaches in Science Instruction in Grades Four Through Nine." Bulletin of Science & Technology 13 (1993): 74-82

19) Zimbler, Seymour. "Backpacks: Do They Cause Back Aches in Schoolchildren?" Child Health Alert 125 (2000): 1

Appendix A

Backpack and Back Pain Questionnaire

Questionnaire on Backpacks and Back Pain

Please answer the following questions as completely and accurately as possible. You may take this survey home and ask your parents for assistance. If you have any questions, please contact either your teacher, Alka Basil (abasil@wpi.edu), or Alison Bailey (abailey@wpi.edu).

1.) What is your age?

2.) Circle the one that applies to you:

Male Female

3.) What race do you consider yourself?

African American
Asian/Pacific Islander
Hispanic
Caucasian
Other

4.) What is your ethnicity (for example, Irish-American, Portuguese, Chinese)?

5.) What is your current grade level (circle the one that applies)?

4th 5th 6th 7th 8th 9th

6.) Do you carry a backpack to school?

YES NO

a.) If yes, how often do you carry a backpack?

once/twice per month once a week 3-4 days a week all the time

b.) How do you get home?

I walk home I ride the bus home I get a ride home by a friend/family c.) How long did you carry your backpack on your way back home from school yesterday (or the last day you went home from school) (circle the one that applies)?

a.) less then 5 minutes
b.) 5-10 minutes
c.) 10-15 minutes
d.) 15 -20 minutes
e.) more then 20 minutes

c.) Was that a typical day in terms of how long you carried your backpack?

YES NO

d.) If it wasn't a typical day, do you usually carry your backpack for:

a lot longer time   a little longer time   a little shorter time   a lot shorter time

7.) Do you carry a backpack at any other time besides when going to school?

YES NO

8.) What is the brand name of the backpack that you carry?

9.) Is your backpack designed to be slung across one or two shoulders?

One   Two   Other ______________________________ (describe)

a.) If **one shoulder**, please describe the different ways you are likely to carry your backpack (for example, slung around your shoulder, across chest, around neck, etc.)

b.) If **one shoulder**, which manner of carrying your backpack is more comfortable?

10.) If your backpack is designed to be slung across **two shoulders**: How much of the time do you actually carry your backpack on both shoulders?

never   rarely ever   sometimes   much of the time   all of the time

11.) Does your backpack have a waist-belt or any other supporting strap other than the shoulder straps? Please describe the "device".

a.) If so, how often do you use it?

Never   Very Rarely   Some of the Time   Most of Time

Almost all of the Time   All of the Time

12.) How many books are you carrying in your backpack today?

13.) How big and heavy is the largest book in your backpack (approximate thickness in inches)? Is the book a hardcover?

14.) How big and heavy is the smallest book in your backpack (approximate thickness in inches)? Is the book a hardcover?

15.) Is this a typical load for you?

YES   NO

a.) If not, is the load in your backpack usually:

Much heavier   Somewhat heavier   Somewhat lighter   Much lighter

16.) a.) How many personal items (not needed for your schoolwork) do you carry in your backpack?

0-5 5-10 10-15 Over 15

b.) What is the estimated weight of all the personal items you carry compared to your heaviest book in your backpack?

a lot less a little less about the same a little more a lot more

17.) Do you feel that your backpack is?

a.) too heavy to be carried comfortably most of the time
b.) too heavy to be carried comfortably some of the time
c.) not a problem to carry

18.) Among your family and friends, which of the following best describes how you are expected to react to pain?

don't whine minimize pain acknowledge pain expected to discuss pain in detail

19.) How common is it for back pain to be a problem for people of your age? Why or why not?

20.) What do you think are the most likely causes of back pain in people your age?

21.) Have you experienced backache or back pain? If no, please go to question 24.

YES NO

a.) If you have had back pain, please rate the severity of your pain:

extremely painful somewhat painful not very painful

b.) Which of the following best describes the type of pain:

acute, sharp pain dull, throbbing pain

c.) If you have had back pain, what would you say best describes the pain:

periodic twinges decreasing pain increasing pain steady pain

d.) If you have had back pain, circle the phrase that best describes how often have you experienced the pain.

More than once a day	Once a day
More than once a week	Once a week
More than once a month	Once a month

e.) If you have had back pain, has the degree of your back pain changed over the last month?

it has not changed gotten much better gotten a little better

gotten a little worse gotten much worse

f.) If you have had back pain, do you think the pain was caused by your backpack or did your backpack make it worse?

YES NO

If you answered NO to the above question, please go to question 24.
If you answered YES to the above question, please describe:

22.) If you experience back pain that you feel could be connected with carrying your backpack, when is the pain most likely to occur? Circle all that apply.

when you put your backpack on
as soon as you start carrying your backpack but it goes away soon
after you have been carrying your backpack for a while
after you have taken your backpack off

23.) Are some ways you carry your backpack more likely to hurt your back (or some other part of your body) more than others?

24.) Do any of your family members have any back problems or challenges? If so, please describe the problem briefly below.

25.) In your opinion, circle the type of person who you feel is most likely to get back pain.

Elderly woman (over 65 years of age)
Elderly male (over 65 years of age)
Elderly people in general (men + women, both over 65 years of age)
Adult woman (40-65 years of age)
Adult male (40-65 years of age)
Adult people in general (men + women, both 40-65 years of age)
Young woman (20-40 years of age)
Young man (20-40 years of age)
Young people in general (men + women, both 20-40 years of age)
Female Student
Male Student
Students in general

26.) If you have access to a bathroom scale please do the following:

a.) Weigh yourself (please remove shoes and any heavy objects from pockets, i.e. keys, change etc.). Record this weight below.

b.) Put on your backpack. Weigh yourself and your backpack (backpack should containing everything you carried home from school this day). Record this weight below.

c.) Remove shoes and record your height using a tape measure below.

27.) If you don't have access to a bathroom scale, and wish to participate, please see your school nurse and ask to use her scale and tape measure after school hours.

28.) Do you have any questions about back pain or backpacks that you would like answered? Please list the questions, and we will try and get back to you as soon as possible.

Appendix B

Social Awareness Survey

PRE-COURSE EVALUATION

1.) What grade are you in?

9th 10th 11th 12th

2.) Rate the following headlines in the order in which you would be likely to read them with 1 being the most likely to be read and 16 the least likely.

a.) "Elian Gonzalez Is Returned To His Father." ______
b.) "Partial-Birth Abortion Is Banned In Texas." ______
c.) "New Pictures From The Hubble Space Telescope Released." ______
d.) "Scientists Have Cloned the First Human Cell." ______
e.) "New Drug For The Treatment of Cancer Approved." ______
f.) "A New Treatment for Scoliosis Developed." ______
g.) "Sega Has Just Released A New 3-D Gaming System." ______
h.) Attendance at Bruins Game down 10% ______
i.) "Picasso Exhibit Comes To Boston." ______
j.) "Best And Worst Dressed At The 2000 Grammy's." ______
k.) "Taiwan Claims Its Independence." ______
l.) "Israel Recognizes a Palestinian State." ______
m.) "The Back Pain Problems of Today's Teenagers." ______
n.) "New Star Wars Movie To Be Released in October And Stars . . ." ______
o.) "NFL Lineup Preview." ______
p.) "Red Sox Win Ten Straight Games." ______

3.) Rate the following topics in the order in which you would be likely to read them with 1 being the one most likely to be read and 15 being the least likely to be read.

a.) Sports and Recreation ______

b.) National Politics ______

c.) Current Events (Local) ______

d.) Health Notices and Recent Medical Research ______

e.) Recent Developments in Science ______

f.) Style and Entertainment ______

g.) Crime and Justice ______

h.) Science Fiction ______

i.) Romance ______

j.) Fine Arts ______

k.) Genetic Engineering ______

l.) Religion ______

m.) Business and Enterprise ______

n.) Video Games ______

o.) Computers ______

Appendix C

Project Proposal

To Whom it May Concern,

We wish to introduce a four-week interdisciplinary science and health curriculum into one or more public school systems that will combine concepts from the physical sciences, such as physics (mass, force, and leverage), in addition to some from the biological sciences (such as evolution) in understanding how these subjects relate to the students' lives. The effects of weight, style, and manner of carrying a backpack on posture, back pain, and risk of scoliosis will be studied as a way of placing the sciences in social context while covering subjects likely to be addressed in the science and technology MCAS exam.

Recently, researchers have found that students' with heavy backpacks tend to complain of back pain and in general have poor posture. It has been shown that improper use of a backpack (i.e. carrying the backpack on one shoulder, putting excess weight in the backpack) does not cause scoliosis, however children with scoliosis do complain of back pain. This back pain may be enhanced by carrying too much weight in the backpack or carrying the backpack improperly.

We will be obtaining our data from the 5th-8th grade students from the Somerville and Worcester public schools. In addition, we hope to obtain data points from students in the suburbs of Worcester. Data such as weight of student and backpack, model of backpack, contents of backpack (textbooks vs. personal content), manner in which student carries backpack, and how backpack contents are arranged. In addition, in Somerville we will be taking part in the annual scoliosis screening of students in the 6th-8th grade and comparing backpack data to the outcomes of these screenings. We are open to being involved in scoliosis screening in other school districts as well.

In addition to involving 5th -8th grade students in the data collection aspect of our project, we also desire to introduce a two-week curriculum to these students. The first week of the curriculum will involve lessons on forces, stress, and strain and the effects they play on the lattismus dorsi and vertebral column. The effects of backpack weight on the students' back muscles, which leads to aches and pains, and on the vertebral column, which could possible lead to scoliosis will be enforced. Independently, students will be expected to research the topic of scoliosis and prepare a short paper on the subject matter. These subjects will also help students' on MCAS exams, since the topic of forces seems to be a prominent in the science portion of the exam.

Students will also learn how to graph and analyze the data that has been gathered. Tools such as graphical calculators and computers will be used for this purpose, so the students will gain knowledge and understanding on technology that is used in the marketplace today. The MCAS exam requires students to be able to use more complex tools to represent quantitative data, describe trends in data even when patterns are not exact, and represent data using tables, models, demonstrations, and graphs.

Evaluations will be given to the students before and after the curriculum to assess student's knowledge. The evaluations will ask questions in a style similar to the science and technology section of the MCAS so that some indication can be given to student's performance on the coming MCAS exams.

The curriculum for the 9th grade students will be more comprehensive and detailed than the one described above for the middle school students. Students will be expected to combine lessons in physics, biology, and statistics to solve a "real-life" problem that has relevance on their lives and the lives of their brothers and sisters. They will use the knowledge they have gained about forces and strain and how they effect muscles, posture, and scoliosis to design the optimum backpack. The specifics of the curriculum for 9th graders is broken down below.

First, the consequences of the weight of the backpack and the manner in which this force is distributed across and along the back will be studied for typical backpacks. The manner in which students actually carry their backpacks and how much they weight will also be analyzed, because this has a significant effect on stress and force distribution of the backpack's weight. In addition, the method of carrying the backpack may place additional strain on the lattismus dorsi muscle along with the vertebrates covering the spinal cord. Students will learn that it not only matters how much their backpacks weigh, but also the manner in which the weight is distributed across their backs that effects posture and the onset of scoliosis. Within this physics lesson topics such as vectors, forces, stress distribution, leverage, and free body diagrams will be studied. Both the 5-8th grade and 9-10th grade learning standards for the MCAS cover the topic of vectors and forces. On the MCAS students are expected to have a fundamental knowledge about the effects of forces according to Newton's Three Laws, and how forces may be reinforced if they are in the same direction and canceled if they are in opposing directions. The effects of forces upon an object (in our case the student's back) is also material to be studied.

In the biological sciences, several topics will be studied. These topics include the evolution of four-legged primates to two-legged primates and the consequences of applying forces to the dorsal area in these two types of animals. Horses and donkeys, both four-legged animals, have been used to carry large loads for extended periods of time, and these loads are applied in such a manner as to evenly distribute the weight across the animal's back. A comparison on how backpacks distribute the weight of the load on animals and humans and the consequences on muscles and bone structure will be applied.

Students will then be asked to expand upon what they have learned and perform experiments based on this knowledge. They will be expected to weigh their backpacks and determine the forces and strain distribution exerted on their back and spinal cord in accordance to how they carry their backpack. In addition, they will be asked to compare the weight distribution of their packs to what backpack manufacturers have designed. Students will then research and compare different backpack characteristics and designs from different manufacturing companies and determine the best backpack on the market and how it should be carried. Lastly, students will be placed into groups and each group will design their concept on the ideal or optimum backpack design for a certain age population dealing with books, papers, and related school material. They will present their creation to their peers for critical evaluation and to a committee of teachers and adults for other rewards.

The project stated above ties nicely with educator's inquiry goals for 5th-8th graders for the MCAS. Students will be describing trends in data even when patterns are not exact by analyzing the data they collected (whose outcome will not be known to anyone unlike traditional controlled experiments at school). They will also be reformulating ideas and technological solutions based on evidence and designing a solution involving a technological problem and describing its advantages and disadvantages by designing new backpacks. In addition, students will represent data and findings using tables, models, demonstrations, and graphs during their presentations. They will also be communicating ideas and questions generated and suggest improvements to the current backpacks on the market.

This project is also feasible with the inquiry goals set by educators for 9th-10th for the MCAS. Students will be using a range of exploratory techniques ranging from literature searches, experiments, research, and data logging in their quest to find the best backpack on the market. In addition, the students will be selecting ways of recording and interpreting data; selecting appropriate means of representing, communicating, and defending a scientific and technological argument supporting their choice of backpack(s); and interpreting data in the light of experimental findings.

To test the feasibility of this new curriculum we will be administering evaluations that we will be creating, at the beginning, middle, and end of the four-week term. The questions on the evaluations will be formatted with the MCAS exam in mind in an attempt to shift the students mind set from traditional ways thinking to one that is more applicable in today's world. Thank you very much for your consideration and support.

Sincerely,

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Appendix D

Massachusetts Science and Technology Curriculum Framework
Strand One and Two

Grade Span	Learning Standards
5 – 8 *Inquiry*	• Note and describe relevant details, patterns, and relationships. • Differentiate between questions that can be answered through direct investigation and those that cannot. • Apply personal experience and knowledge to make predictions. • Apply multiple lines of inquiry to address and analyze a question, e.g., experimentation, trial and error, survey, interview, and secondary sources. • Design an investigation or problem specifying variables to be changed, controlled, and measured. • Use more complex tools to make observations, and gather and represent quantitative data, e.g., microscopes, graduated cylinders, computer probes, stress and impact testers, wind tunnels and timers. • Describe trends in data even when patterns are not exact. • Reformulate ideas and technological solutions based on evidence. • Analyze alternative explanations and procedures. • Represent data and findings using tables, models, demonstrations and graphs. • Communicate ideas and questions generated, and suggest improvements or alternatives to the experimental techniques used. • Communicate the idea that usually there is more than one solution to a technological problem. • Design a solution involving a technological problem and describe its advantages and disadvantages.

Grade Span	Learning Standards
9 – 10 *Inquiry*	• Distinguish those observations that are relevant to the question or problem at hand. • Formulate testable questions and generate explanations using the results of predictions. • Use a range of exploratory techniques, e.g., experiments, information/literature searches, data logging, research, and development, etc. *continued on next page*

Grade Span	Learning Standards
9 – 10 *Inquiry*	*continued from previous page* • Make decisions about the range and number of independent variables and how to control other variables in designing experiments. • Select and use common and specialized tools to measure the dependent variable. • Select appropriate methods of recording and interpreting data. • Accurately use scientific and technological nomenclature, symbols and conventions when representing and communicating ideas, procedures, and findings. • Select appropriate means for representing, communicating, and defending a scientific and technological argument. • Question interpretations or conclusions for which there is insufficient supporting evidence, and recognize that any conclusion can be challenged by further evidence. • Formulate further testable hypotheses based on the knowledge and understanding generated. • Interpret data in the light of experimental findings, and appropriate scientific and technological knowledge and understanding.

Grade Span	Learning Standards
11 – 12 *Inquiry*	Inquiry during these years is characterized by work that builds upon the inquiry skills honed during grades 9 and 10, and expands them to include reflecting on the assumptions and concepts that guide student investigations. Students need to learn how to construct and evaluate their own and others' scientific and technological explanations, as well as learn how to evaluate evidence.

Grade Span	Learning Standards and Examples of Student Learning
5 – 8 *Physical Science*	*Properties of Matter* • Identify properties that allow materials to be distinguished from one another and often make them well suited to specific purposes. *For example, compare and measure different materials in terms of their characteristic properties such as density, texture, color.* • Identify and classify elements and compounds with similar properties, such as metals, metalloids and non-metals; acids and bases; combustibles and non-combustibles • Present evidence that a chemical change involves the transformation of one or more substances into new substances with different characteristic properties. Give examples that such changes are usually accompanied by the release of or absorption of various types of energy, especially radiant energy such as heat or light. • Explore and describe that the mass of a closed system is conserved. *For example, if a wet nail is put in a jar and the lid closed, the nail will rust (oxidize) and increase in mass but the total mass in the contents of the jar will not.* • Measure and predict changes in the pressure, temperature, or volume of a gas sample when changes occur in either of the other two properties. *Particulate Model of Matter* • Describe a particulate model for matter that accounts for the observed properties of substances. • Recognize and explain how experimental evidence supports the idea that matter can be viewed as composed of very small particles, (such as atoms, molecules and ions), which are in constant motion. Illustrate understanding that particles in solids are close together and not moved about easily; particles in liquids are about as close together and move about more easily; and particles in gases are quite far apart and move about freely. • Provide evidence that shows how the conservation of mass is consistent with the particulate model that describes changes in substances as the result of the rearrangement of the component particles. *continued on next page*

Grade Span	Learning Standards and Examples of Student Learning
	continued from previous page
5 – 8 *Physical Science*	*Motions and Changes in Motion* • Show and describe how forces acting on objects as pushes or pulls can either reinforce or oppose each other. • Demonstrate that all forces have magnitude and direction. Create situations to model how forces acting in the same direction reinforce each other and forces acting in different directions may detract or cancel each other. • Describe and represent an object's motion graphically in terms of direction, speed, velocity, and [or] position versus time. Also describe these quantities verbally and mathematically.
	Transformations of Energy • Represent an understanding that energy cannot be created or destroyed but exists in different interchangeable forms, such as light, heat, chemical, electrical, and mechanical. • Present evidence that heat energy moves in predictable ways, flowing from warmer objects to cooler ones until both objects are at the same temperature. *Predict and use tools to measure this movement.* • Illustrate an understanding that energy comes to the Earth as electromagnetic radiation in a range of wavelengths, such as light, infrared, ultraviolet, microwaves, and radio waves. *Explain ways in which the amount of each type of radiation reaching the surface of the Earth depends on the absorption properties of the atmosphere.* • Investigate and describe an understanding of visible electromagnetic radiation, which we generally call light, with reference to qualities such as color and brightness. Illustrate understanding that light has direction associated with it, and can be absorbed, scattered, reflected or transmitted by intervening matter. *Demonstrate and explain refraction as the process by which light's direction can be changed by passing from one medium to another.* • Explain ways that energy can be changed from one form to another. *For example, heat and light are involved in physical or chemical changes and at times may be accompanied by sound.* • Demonstrate principles of electrical circuits. *Use wires, batteries, bulbs and instrumentation to measure and analyze electrical energy resistance, current and power. Use electric currents to produce electromagnetic coils of wire, and, conversely, use a moving magnet to generate a current in a circuit.*

Grade Span	Learning Standards and Examples of Student Learning
9 – 10 *Physical Science*	*Structure of Matter* • Explore and describe how matter is made up of elements, compounds, and numerous mixtures of these two kinds of substances. *Students might design and conduct investigations that explore ways to demonstrate this.* • Demonstrate through the use of manipulatives that atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. • Represent an understanding that compounds form when atoms of two or more elements bond. *Give examples that chemical bonds form when atoms share or transfer electrons.* • Group elements and compounds into classes, based on similarities in their structures and resulting properties. • Describe an understanding that nuclear changes often result in the emission of high-energy electromagnetic radiation and particles, and present evidence on ways that this has physical repercussions on other materials. • Illustrate an understanding that energy is released in certain nuclear reactions and chemical reactions can be controlled and put to use, or released suddenly and destructively in explosions, fire, or high-energy chemical events. *Provide examples of situations in which this has occurred in recent history.*
	Interaction of Substances (Chemical/Physical Changes) • Present evidence that solubility of substances may vary with temperature and with the natures of the solute and the solvent. *Plan and conduct investigations in which the temperature, solute or solvent is varied while the other variables are kept constant.* • Suggest how balanced electrical forces between the charges of the protons and electrons are responsible for the stability of substances. *Students might design an investigation to show how chemical interactions or physical changes occur when these forces are altered.* • Explain chemical changes in terms of rearrangements of atoms or molecules, which are made possible by the breaking and forming of chemical bonds. • Summarize chemical reactions by symbolic or word equations that specify the reactants and products involved. • Illustrate ways in which the periodic table is useful in predicting the chemical and physical properties of known elements and those yet to be discovered.

Grade Span	Learning Standards and Examples of Student Learning
9 – 10 *Physical Science*	*Forces and Motion* • Demonstrate that all forces are vector quantities, having both magnitude and direction. *Explore ways in which forces acting in the same direction reinforce each other. Also explore ways in which forces acting in different directions may detract from or cancel each other.* • Represent an understanding that if an object exerts a force on a second object, then the second object exerts an equal and opposite force on the first object. • Describe and represent changes in motion or momentum in terms of being caused by forces. *Students might set up demonstrations that show the result of forces on motion, e.g. gravity, friction or electrical.*
	Conservation and Transmission of Energy • Explore and explain how the total amount of mass and energy remains constant in any closed system. *Present evidence to show that Earth is a nearly closed system with respect to matter, but not to energy. Describe the implications of this idea for life and earth sciences. Be aware of inputs of matter.* • Describe the nature of waves, such as electromagnetic waves or sound waves, in terms of wave length, amplitude, frequency, and characteristic speed. *Present evidence that waves can be used to transmit signals or energy without the transport of matter.* • Design and conduct an investigation that explores how electromagnetic waves, unlike sound waves, can be transmitted through a vacuum. • Demonstrate that the same concepts of energy, matter and their interaction apply both to biological and physical systems on Earth and in the observable Universe.

Grade Span	Learning Standards and Examples of Student Learning
11 – 12 *Physical Science*	*Forces and Motion* • Explore and illustrate situations that show how the position and motion of an object are judged relative to a particular frame of reference. Examine evidence that an object at rest tends to stay at rest unless acted upon by some outside force. Also examine evidence that an object in uniform motion remains in this state of motion with constant momentum unless acted upon by an unbalanced force. • Illustrate and describe an understanding that motion can take place in two or three dimensions. *Describe an object's motion in terms of velocity or acceleration, and represent motion in various ways, including distance-time, and speed-time graphs, as well as by mathematical equations, and vectors.* • Explore and describe an understanding that acceleration is the rate of change of velocity, where the change may be in magnitude or direction. *Students might represent the relationship of force, acceleration and mass using physical, conceptual, and mathematical models.* • Demonstrate an understanding that constant motion in a circle requires a force to maintain it, because velocity is constantly changing.
	Conservation and Transmission of Energy • Investigate and describe the idea that the total quantity of energy in a closed system remains constant in any chemical or physical change, although its usefulness to prompt further change is reduced through each process as randomness increases. *Describe the consequences of this for living systems.* • Conduct investigations to gain evidence that interactions of matter with electromagnetic radiation, electricity, or heat can produce useful evidence regarding the structure and composition of matter. • Design and conduct investigations which illustrate that the loss or gain of heat energy by a sample of matter is related to a temperature change, which depends on the sample's mass, the nature of its material, and the environment in which it is placed. • Provide evidence that characteristic and predictable quantities of energy are associated with each chemical and physical change.

Appendix E

Entire S-STS Curriculum

Source: Business Week, August 16, 1999 i3642 p115.

Title: ``Mom, My Back Really Hurts''.(heavy backpacks and poorly designed computer workstations causing back problems among school children)

Subjects: Backache - Causes of
Children - Health aspects
Students - Health aspects
Backpacks - Health aspects
Workstations (Computers) - Health aspects
Locations: United States

Electronic Collection: A55441724
RN: A55441724

At age 15, Elizabeth Nemrava, of Winnetka, Ill., suffers from shoulder and back pain so severe that she winces when she bends over or abruptly twists around. Her mother, Pat, is convinced the problem stems from the heavy backpack that her daughter, now a high school sophomore, has been hauling around since middle school. ``Elizabeth weighs 110 pounds, and her backpack weighs 38,'' her mother says. ``That has to be straining her muscles and bones.'' Just as adults face occupational hazards, the work of today's school kids also carries risks. Medical professionals report an increase in complaints about back, neck, and shoulder pain linked to two factors: backpacks overloaded with books and improperly designed computer workstations where kids spend hours on end. It used to be that ``if children had back pain, it meant they had a serious medical condition,'' such as a tumor, says Dr. John Sarwark, interim chief of the pediatric orthopedic surgery department at Children's Memorial Hospital in Chicago. ``Now we're seeing more and more kids with the kind of mechanical back pain much more typical of a middle-aged adult.'' The effect of ergonomic factors on children's musculoskeletal health remains undocumented. But physicians, chiropractors, and physical therapists say that the potential dangers range from discomfort, pain, and muscle strain in the short term to chronic conditions. Already, back pain is the most common ailment of working Americans, costing the U.S. economy $50 billion annually in lost wages and productivity. ``If we don't start paying attention to these issues in children, we may be creating a generation of adults with even greater back and neck problems than we're seeing today,'' says Dr. Jerome McAndrews, spokesman for the American Chiropractic Assn., one of several professional groups focusing attention on the issue (table). Take the ubiquitous backpack. With many schools limiting the use of lockers for security purposes, students lug around their books (and weighty laptops) throughout the day. ``We see kids carrying packs that weigh 30, 40, even 50 pounds,'' says Betty Strauss, a certified school nurse in Montclair, N.J. Such excessive weight forces a child to lean forward, which flattens the natural curve in the lower back. This promotes poor posture and can cause back and neck pain, says Jan Richardson, president of the American Physical Therapy Assn. And if kids sling their packs over one shoulder, as they're prone to do, they can strain shoulder and neck muscles and cause a temporary curvature of the spine. Straps that aren't adjusted properly can damage nerves around the collarbone.

HUNCHED. Health experts are less certain about the impact of ergonomically incorrect computer stations. But given an Education Dept. push to put Net-ready computers in every classroom by 2000, concern is mounting. In one of the first studies of its kind, researchers at Cornell University in Ithaca, N.Y., observed third-, fourth-, and fifth-graders at 11 schools and found a ``striking misfit'' between the size of the children and their gear. With monitors and keyboards often set too high, more than a third of the kids sat in ways that resulted in craned necks, hunched shoulders, awkwardly placed wrists, and other unhealthy postures, says Alan Hedge, a professor of ergonomics at Cornell. What's more, at home children tend to work on computer setups designed for their parents. In adults, the risk of back, neck, and shoulder pain, as well as repetitive stress injuries to the hands and wrists, increases with each hour spent in front of a monitor. It's not known whether children, who have more flexible bones and joints, suffer similar effects. But ``there's no reason to believe that they don't,'' Hedge says. Medical experts say that parents can lower their children's risk of problems with simple preventive steps. When using backpacks, kids should never carry more than 15% of their body weight, according to guidelines issued by the American Occupational Therapy Assn. Wide, padded shoulder straps are best, and they should fit snugly so the weight of the pack is evenly distributed and supported by back and abdominal muscles. For kids who already have back problems, more drastic measures may be needed. Dr. Jeffrey Neustadt, chief of orthopedic surgery at All Children's Hospital in St. Petersburg, says he sees two or three children a week with pain so severe that he recommends their school issue a second set of books. That way, they won't have to go to and from school with a heavy load. Other doctors prescribe a backpack on wheels, such as the kind sold by RollerBags. The San Diego company was founded by Ricky Hussain, an engineer and father of four whose kids were complaining of back discomfort.

PARALLEL ARMS. When using a PC, kids should sit erect with lower backs supported and eyes level with the top of the screen. ``They shouldn't have to crane their necks,'' says Karen Jacobs, an occupational therapist and ergonomist who teaches ``healthy computing'' classes at public schools in Andover, Mass. Arms should be positioned parallel to or just slightly above the keypad and mouse. If equipment can't be adjusted, Jacobs suggests a stack of books on the chair to raise a child's body to the proper height and a box to serve as a foot rest. ``Never let a child sit in front of a screen for too long,'' she adds. ``They should get up every 20 minutes or so and move around or stretch.'' A few companies make ergonomic kids' furniture. Kin-der-Link in New York (800 545-4474, www.kinderlink.com) offers adjustable computer stations for $875 and up. MediaFocus International in Naples, Fla. (888 232-3686, www.mediafocus.com/furniture/kids_ch.html), imports European-made children's furniture, with prices starting at $279. Regular exercise is a good way to keep bones and muscles strong, says Dr. Sarwark. He prescribes a simple exercise for kids who sport a heavy backpack or sit for long periods using a computer: Have the child lie flat on the floor to give the back an ``easy, passive stretch.'' (Doctors caution that a physician should always evaluate severe and persistent back pain.) For generations, parents have been urging their children to stand and sit up straight. Given the occupational hazards of growing up today, those admonitions are more important than ever.

Keeping Young Backs Healthy If your kids lug around heavy backpacks or spend hours hunched over a computer keyboard, make sure they periodically... -- Lie flat on the floor, face up, for a passive stretch -- Stand with feet slightly apart, raise both arms above the head, and reach upward -- Shrug the shoulders toward the ears, count to ten, release, and repeat several times -- Extend the arms in front with palms facing outward, stretch, and hold for a count of ten

Kids' Ergonomics

NAME/PHONE	DESCRIPTION
AMERICAN CHIROPRACTIC ASSN. 800 986-4636 www.amerchiro.org	Offers pamphlets on how kids can maintain a healthy back and spine
AMERICAN OCCUPATIONAL THERAPY ASSN. 301 652-AOTA www.aota.org	Lets you download a screen saver illustrating ergonomically correct posture
AMERICAN PHYSICAL THERAPY ASSN. 703 684-2782 www.apta.org	Lists physical therapists in different areas
ROLLERBAGS 888 889-6388 www.rollerbags.com	Sells book bags on wheels
UPRIGHT CONSULTING 800 537-1650	Offers a booklet Children and Safe Computing for $9.95

-- End --

North High Game Show Muscle Quiz Show

1.) Name this muscle:
  Clue 1: ORIGIN
    Tip of shoulder, collarbone (clavicle)
  Clue 2: INSERTION
    Humerus (upper arm bone)
  Clue 3: ACTION
    Abducts (raises) arm, anterior fibers flex and medial rotate, posterior fibers extend and lateral rotate.
  Clue 4: Picture
  Answer: Deltoid
2.) Name this muscle:
  Clue 1: ORIGIN
    Upper back, back of head and neck
  Clue 2: INSERTION
    Clavicle (collarbone) to scapula (shoulder blade)
  Clue 3: ACTION
    Extends head and neck, elevates clavicle (shrug shoulders)
  Clue 4: Picture
    Answer: Trapezius
3.) Name this muscle:
  Clue 1: ORIGIN
    Ribs
  Clue 2: INSERTION
    Ends at the scapula (shoulder blade)
  Clue 3: ACTION
    Pulls shoulders forward.
  Clue 4: Picture
  Answer: Serratus Anterior
4.) Name this muscle:
  Clue 1: ORIGIN
    Middle of back
  Clue 2: INSERTION
    Humerus (upper arm bone)
  Clue 3: ACTION
    Lowers arm and extends shoulder
  Clue 4: Picture
    Answer: Lattismus dorsi
5.) Name this muscle:
  Clue 1: ORIGIN
    Upper chest
  Clue 2: INSERTION
    Humerus (upper arm bone)
  Clue 3: ACTION
    Flexes shoulder and lowers arm

Clue 4: Picture
Answer: Pectoralis Major

6.) Name this muscle:
Clue 1: ORIGIN
Shoulder blade
Clue 2: INSERTION
Humerus (upper arm bone)
Clue 3: ACTION
Lateral rotation of arm and stabilizes shoulder
Clue 4: Picture
Answer: Infraspinatus

7.) Name this muscle:
Clue 1: ORIGIN
Posterior edge of scapula
Clue 2: INSERTION
Humerus
Clue 3: ACTION
Lateral rotation of the humerus
Clue 4: Picture
Answer: Teres Minor

8.) Name this muscle:
Clue 1 ACTION
Medial rotation and stabilizes shoulder
Clue 4: Picture
Answer: Teres Major

9.) Name this muscle:
Clue 1: ORIGIN
Hip
Clue 2: INSERTION
Lower vertebrae (lumbar region of spine) and adjacent surfaces of ribs
Clue 3: ACTION
Flexes spinal cord
Clue 4: Picture
Answer: Quadratus Lumborum

10.) Name this muscle:
Clue 1: ORIGIN
Back of head
Clue 2: INSERTION
Sacrum
Clue 3: ACTION
Extends spinal column
Clue 4: Picture
Answer: Eractor Spinae

11.) Name the region of the spine:
Clue 1: Smallest of the vertebrae
Clue 2: Densest bone tissue

Cue 3: 7 vertebrae that make up the neck
Clue 4: Picture
Answer: Cervical

12.) Name the region of the spine:
Clue 1: Vertebrae contain articular surfaces which help attach to the ribs
Clue 2: Compose first primary curve (curve present at birth)
Cue 3: 12 vertebrae that make up the upper back
Clue 4: Picture
Answer: Thoracic

13.) Name the region of the spine:
Clue 1: Bones must support most amount of weight, therefore they are the strongest and the largest.
Clue 2: Compose second secondary curve
Cue 3: 5 Vertebrae that make up the lower back
Clue 4: Picture
Answer: Lumbar

14.) Name the region of the spine:
Clue 1: Triangular in structure
Clue 2: Protect internal organs
Cue 3: 5 vertebrae that forms base of vertebral column
Clue 4: Picture
Answer: Sacrum

15.) Name the region of the spine:
Clue 1: Forms the base of the vertebral column
Clue 2: Composed of 4 attached vertebrae
Cue 3: also known as the tailbone
Clue 4: Picture
Answer: Coccyx

16.) List four key things in maintaining muscular balance in the lower back:
- a.) Flexible and strong lower back muscles
- b.) Strong abdominal muscles
- c.) Flexible quadriceps and hip flexor muscles
- d.) Flexible and strong hamstring muscles

17.) List three key things in maintaining muscular balance in the upper back:
- a.) Strengthening the trapezius muscle because it gets overstretched with daily living activities.
- b.) Strengthening the rhomboids because they get weak with poor posture.
- c.) Strengthening the neck muscles

18.) List four causes of neck/backpain:
- a.) heavy backpacks
- b.) lack of exercise
- c.) poor posture
- d.) imbalance of muscle strength
- e.) obesity
- f.) lack of muscle tone
- g.) poor sleeping habits

h.) poor work habits/tension

I. Anatomy of the Spine

A. The spinal column is made up of 33 segments, or vertebrae, held together by tough bands of tissue called ligaments. The nerve roots pass through the openings of the vertebrae. Thus, a failure of muscular support or injury may result in pressure or "pinching" upon a nerve, causing pain.

B. There are five sections of the back. They are:

1. cervical vertebrae
    a. seven of them
    b. smallest of the vertebrae
    c. their bone tissue is denser than any other region of the vertebral column
2. thoracic
    a. twelve of them
    b. larger than those in the cervical region
3. lumbar
    a. five of them
    b. found in the lower back area
    c. since it must support the more weight than the vertebrae above them, these bones are larger and stronger than the thoracic and cervical vertebrae
4. sacrum
    a. triangular structure
    b. protects internal organs
    c. composed of five attached vertebrae
    d. formed at the base of the vertebral column
5. coccyx
    a. also called the tailbone
    b. lowest part of the vertebral column
    c. composed of four attached vertebrae

II. Prevention of Problems with Proper Posture

A. Neck

1. A healthy neck supports your head, keeping it aligned with the rest of the spine in a proper, balanced posture.
2. The neck has a slight natural curve which sits on the top of the two curves in the middle and lower back.

B. Posture
   1. Correct posture maintains all three curves and prevents undue stress and strain by distributing weight evenly.
   2. When your back is balanced, it is self-supporting and requires little help from your back muscles. In correct, fully erect posture, a line dropped from the ear will go through the tip of the shoulder, the middle of the hip, the back of the knee cap, and the front of the anklebone.
   3. Also, your internal organs have room to function normally and blood circulates freely for best total fitness.

C. Ways to correct and Improve Posture
   1. sitting position
      a. the three back curves must be maintained
      b. if you cannot sit without slouching forward or backward, you need to support yourself with hands and arms or lean against a chair or wall
   2. lying position
      a. in a side lying position, the spine needs to be kept in line
      b. avoid propping head or upper body up on an arm and hand
      c. propping compromises the neck, shoulders, arms, wrists, and hands
      d. head should remain relaxed; legs should be together

III. Group Activity

Ask for volunteers for the following demonstrations. Have the class answer whether the student did these function the "correct way."

A. Standing and Lifting
B. Sitting Correctly
C. Putting your Back to Bed
D. Ideas for Daily Living
   1. packs and sore backs

2. bicycling and your back
3. footwear
4. neck tips

IV. Muscles

V. Effect

A. pain and injury
1. can be caused by increasing the pressure on the discs of the spine
2. in a resting or lying position the pressure on the lumbar discs is the lowest; this is why lying down often relieves pain, because it reduces pressure on the discs
3. when standing, the amount of pressure exerted on the lumbar disc increases twice the amount of lying down; for a 154 lb. man, the amount of pressure is over two times the body weight **(ask question)**
4. a bending and twisting motion involving flexion or rotation of the spine, causes five times more pressure than a resting position **(ask question)**
5. try to avoid exercises or daily activities where flexion and/ or rotation of the spine are part of trunk movement; proper exercises and posture are imperative for strong , healthy back muscles and for reducing pressure on the lumbar discs

B. incidence and impact
1. 75% of all people will experience back pain some point in their lives **(question)**
2. second leading cause of absenteeism from work, after the common cold and accounts for 15% of sick leave
3. back injuries cause 100 million lost days of work annually, and are the most costly for employers
4. the average cost for a claim in 1989 was $18,365
5. role of time
   a. after 52 weeks of back injury disability and absenteeism, only 25% of injured workers return to work
   b. after two year of disability, the return rate is zero

6. for 85% of back pain suffers, the primary site of injury is the lower lumbar spine
7. more than 90% of back-injured patients will recover completely without surgery

C. CAUSES OF PAIN

1. Problems can occur suddenly after an accident or injury, or may occur as the result of a slow, gradual process due to lack of exercise or poor posture.
2. Incorrect posture throws the head forward and puts a tremendous amount of stress on the muscles in the back of the neck and upper shoulders. Muscles in this position maintain a constant state of contraction, resulting in injury and subsequent discomfort.
3. Poor sleeping habits, poor work habits, and tension can all contribute to this problem. While tension is not often the primary cause of back and neck pain, it can certainly worsen pain and make you more prone to injury.
4. Failure to exercise opposing muscle groups can also result in neck and shoulder pain. The imbalance of muscle strength can cause chronic or sporadic tension and tightness in these areas.
5. Some other specific conditions that can lead to muscle deterioration and pain may include a sedentary lifestyle, obesity, and general lack of muscular tone. A healthy, pain-free neck also depends on the condition of your upper back. Because the neck and upper back share the same muscles, the strength and flexibility of the shoulders and upper back muscles are important for keeping the neck balanced.
6. Pain is also generated when muscles go into spasm. While such a spasm may occur as a protective reflex, it intensifies discomfort by reducing circulation and setting up an inflammatory response. Stress of any kind, physical or emotional, may cause spasms in underexercised muscles.
7. Lastly, pressure or "pinching" of the nerves in the spine can cause severe pain that can radiate (travel) down the back and leg.

D. Serious Symptoms

While dull aches can be annoying and even ignored, severe pain or pain accompanied by other symptoms may indicate a serious underlying disease that requires medical attention. If you have any of the following symptoms associated with pain in your neck or back, you are urged to seek medical assistance:

- Fever — May indicate an infection.
- Frequent, painful or bloody urination — May indicate a kidney problem.
- Leg pain traveling down to or below the knee — May indicate a possible disc problem.
- Numbness, tingling, weakness or loss of bladder or bowel control — May indicate a nerve or disc problem.
- Persistent pain that hasn't improved and can not be relieved — May indicate a serious back disorder or injury.

E. Seeking Help

If you have any of the symptoms listed above or have other concerns about your neck or back, you are encouraged to consult with a medical provider. Evaluation of your problem may include a discussion and review of your medical history, a physical examination and diagnostic tests.

To be a better health care consumer, you should prepare for your appointment in advance. You may want to make a written, chronological history of your problem with accurate descriptions of your symptoms. You may also want to prepare a list of questions in advance. By letting your provider know you have prepared these, it may help ensure that you have an exchange of communication and that all of your concerns and questions are addressed.

F. Self Care

Self-care and treatment can be responsibly done under the consultation of a medical provider. The following are some safe and effective methods, but remember, if your back still hurts after a week of self-treatment, seek medical advice.

1. Application of heat or ice

Apply heat and/or ice in a way that makes you most comfortable. To relieve initial pain, you may want to apply ice packs wrapped in towels for 10 minutes every two hours for the first one or two days. Then you may apply heat or ice. Always make sure you have a cloth of some type between your skin and the ice, to prevent freezing the skin and frostbite. It is not recommended that you lie on an ice pack. Since back sprains and strains don't usually cause much swelling, some people find moist heat, such as a hot shower, tub bath, wet towels, or hot water bottle, to be more effective than ice. Limit heat to 15-20 minutes every few hours. Too much heat can make you feel drained and tired, rather than relaxed.

2. Massage

Massage helps increase the blood flow to your muscles, improves muscle tone and helps your muscles to relax. Classes are often offered for massage training and there are resources such as books and handouts available to teach proper massage technique.

3. Medication

Pain relievers, such as acetaminophen, ibuprofen and aspirin can help reduce pain. Be aware that products such as these can cause stomach irritation for some people. Take all medications in the dosages and time schedules recommended on the label.

4. Rest

Try to lie comfortably in a well-supported bed. The best position for your back is on your side with the knees bent. A pillow between the knees may also help increase comfort. Another good resting position is on your back with a pillow underneath your knees. Lying on your stomach or flat on your back with your legs straight out are not recommended positions.

5. Exercise

Once your pain subsides, do the exercises outlined in this brochure. A bit of initial discomfort is normal, but if you avoid exercise for too long, your muscles will stiffen and weaken and may cause you more problems in the future. If you experience any significant pain, stop immediately and seek medical attention. Gradually increase the amount, intensity and frequency of exercise as tolerated. Do not perform any exercise with pain that is increasing or not improving.

6. Stress and Tension Management

Techniques, such as progressive muscular relaxation, exhalation breathing, meditation and guided imagery can help create a more relaxed body that is receptive to healing. You might want to seek out a class or book on one of these topics. Soothing music played on a stereo or radio and resting your body and mind may also be beneficial.

7. Recreational Activities

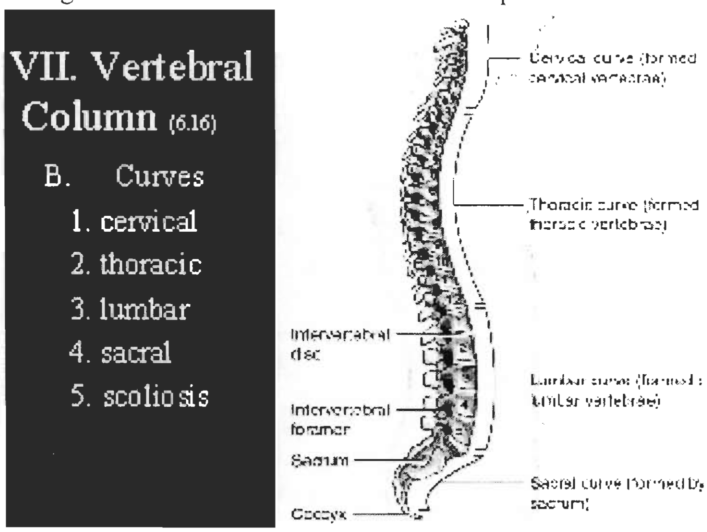
Some activities can be helpful in toning and stretching muscles while reducing the possibility of further injury. Swimming, walking, and water walking are recommended. Conversely, some activities can cause problems if done before symptoms are gone and strength, flexibility and conditioning are restored. Avoid tennis, golf, bowling, racquetball, diving, high-impact aerobics, and other activities that combine sudden bending and twisting.

Lesson: Scoliosis and other Back Injuries Affected by Excess Weight of Backpacks

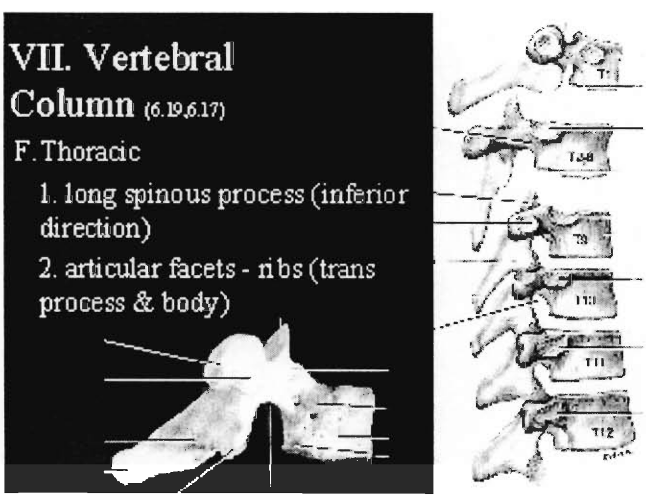
Social Issue: A small number of scoliosis cases result from habitually poor posture, and heavy backpacks are known to cause bad posture as they force students to hunch forward in order to accommodate the weight of the backpack. In addition, heavy backpacks worsen back pain and posture, which can worsen scoliosis for those students that do have this condition (about 1 in 10 students have scoliosis).

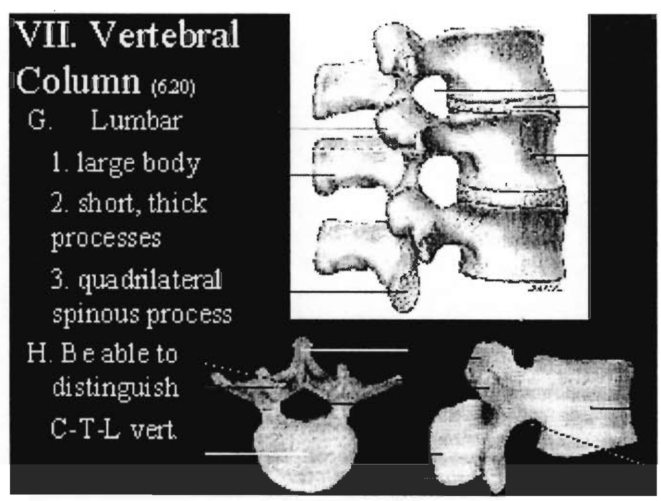
Question: What is scoliosis?

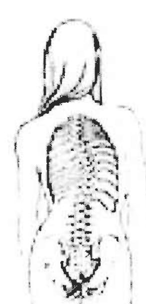
- Scoliosis is defined as lateral (left-to-right) curvature of the spine in the thoracic and/or lumbar regions of the vertebral column. Show picture seen below:

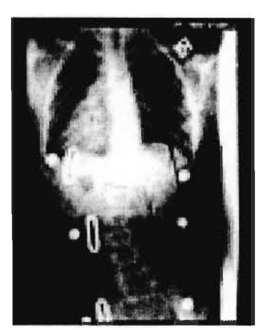


Cervical: C1-C7
Thoracic: T1-T12
Lumbar: L1-L5
Sacral: (Primary)
** The adult spinal column reveals that vertebrae align to form four spinal curves that add strength to the spine and increase the skeleton's balance and ability to hold the body upright.









Who gets scoliosis?

- People of all ages can have scoliosis, but adolescent idiopathic scoliosis (scoliosis of an unknown cause) is the most common type and occurs after the age of ten, mostly after the onset of puberty and during the growth spurt. Girls are more likely then boys to have this type of scoliosis. Early onset idiopathic scoliosis can also occur in children younger then 10, although this is very rare.

Causes of Scoliosis:

- Nonstructural (functional) scoliosis: structurally normal spine that appears curved. This is temporary, changing curve and is caused by underlying condition such as difference in leg length, muscle spasms, or inflammatory conditions such as appendicitis.
- Structural scoliosis: A fixed curve that doctors treat case by case. Sometimes structural scoliosis is one part of a syndrome or disease (such as Marfan's syndrome, an inherited connective tissue disorder) and in other cases it occurs by itself. May be caused by neuromuscular diseases (such as cerebral palsy, poliomyelitis, or muscular dystrophy), birth defects (such as hemivertebra), injury, certain infections, tumors, or unknown factors).

Treatments of Scoliosis:

- Many students who are sent to a doctor by a school scoliosis screening program have very mild spinal curves that do not change much, and thus do not need any treatment. Mild curves are considered to be up to 25 degrees of spinal curvature. Doctors generally observe these patients without treatment to ensure that the curvature does not grow while the patient is growing.
- Doctors advise patients to wear a brace to stop a curve from getting worse when a patient is still growing and has a idiopathic curve that is more than 25-30 degrees. Although bracing cannot correct curvature, it may be effective in halting or slowing its progression.
  The Milwaukee brace consists of metal uprights attached to pads at the hips, rib cage, and neck. The underarm brace uses rigid plastic to encircle the lower rib cage, abdomen, and hips, effectively holding the spine in a vertical position. The Milwaukee brace must be worn outside one's clothing, whereas the underarm brace can be worn out of sight. Braces are usually prescribed to be worn for 22-23 hours per day.
- Surgery for idiopathic scoliosis is usually recommended if the curve has progressed despite bracing, if the curve is greater than 40-50 degrees before growth has stopped in an adolescent, or if the curve is greater than 50 degrees and continues to increase in an adult. The surgical procedure is called spinal fusion, because the goal is to straighten the spine as much as possible and then to join the vertebrae together to prevent further curvature. Spinal fusion leaves the involved portion of the spine permanently stiff and inflexible. While this leads to some loss of normal motion, most functional activities are not strongly affected, unless the very lowest portion of the spine (lumbar region) is fused.

Detection of Scoliosis:

- Doctors:
  a.) Medical History: The patient's parents and family history is studied to look for problems that might be causing the spine to curve.
  b.) Physical Examination: The doctor looks at the patient's back, chest, pelvis, legs, feet, and skin. Checks to see if the shoulders and hips are leveled, head is centered, and whether opposite sides of the body look level. Also examines back muscles while patient is bending forward to see if one side of the rib cage is higher than the other.
  c.) X-ray evaluation:

d.) Curve measurements by looking at the curve on the x-ray image. May measure the angle of the curve this way and also by the scoliometer.

- School Nurses:
  a.) Five views of looking at the back. View I looks at the student from the front, and ensures that the shoulders, waist, and hip are leveled. View II looks at the students back, and ensures the head is centered, shoulders and waist are leveled, and scapula and spine are straight. View III looks at the students side profile and ensures that two of the major curves, round back and sway back are present. View IV looks at the student from the front as they bend over, and ensures that the chest and cage hump are aligned. View V looks at the side profile as the student is bent over to look at the spine hump. Show pictures.
  b.) Controversy whether school screening is cost effective and worth the time.

Activity:
Debate: Divide half the class in favor of school screening and half the class against school screening. Provide students the articles enclosed to get them started, allow them time to research on the internet and/or magazines for further support. Allow approximately 20 minutes for the debate (debate will be well structured, with allowing pro-screening to present argument, anti-screening allowed to refute and then anti-screening presents their argument, with pro-screening getting a chance to refute. Closing arguments from both sides.)

Fact or Fiction?

Circle True or False for the following questions. Be prepared to explain your answers in a group discussion.

1. Following WWII, child nutrition in the 1950s was worse than that of the 1990s.

   TRUE **FALSE**

2. Children in the 1950s were more active than their 1990s counterparts.

   TRUE **FALSE**

3. In 1990 it was estimated that one in twenty children aged nine to eleven were classified as clinically obese.

   TRUE **FALSE**

4. Obese children suffer huge health problems during childhood.

   TRUE **FALSE**

5. Osteoporosis is a progressive disease that affects the bones, with loss of bone mass and deterioration of bone tissue disease.

   TRUE **FALSE**

6. Only five percent of osteoporosis sufferers are men.

   TRUE **FALSE**

7. Osteoporosis occurs later and in a weaker form in white and Asian women who are relatively thin and small-boned.

   TRUE **FALSE**

8. Osteoporosis cannot be prevented.

   TRUE **FALSE**

9. Bone density is improved dramatically through regular exercise, especially weightlifting and weight-bearing activities such as walking.

   TRUE **FALSE**

10. Women with thin bones who get pregnant in their twenties and thirties may be increasing their chances of developing osteoporosis later on.

    TRUE **FALSE**

11. The majority of the bodies' supply of vitamin D is obtained through food.

TRUE **FALSE**

12. People who have low blood levels of vitamin D are at an increased risk for fractures associated with osteoporosis and osteomalacia, softening of the bones.

TRUE **FALSE**

13. Young people are more likely to be deficient in vitamin D.

TRUE **FALSE**

14. It is estimated that as much as forty percent of the U.S. population is vitamin D deficient.

TRUE **FALSE**

15. In Boston area the sunlight from the end of October through the beginning of March is too weak for the skin the produce any vitamin D.

TRUE **FALSE**

FACT OR FICTION ANSWERS

1. **FALSE**

   Despite the food shortages of the post-war period child nutrition was better in the 1950s. 1950s children:

   a. ate more bread and milk, increasing their fiber and calcium intake
   b. drank few soft drinks, deriving less of their energy from sugar
   c. got most of their vitamin C from vegetables rather than juice and drinks
   d. had more fat in their diet

2. **TRUE**

3. **TRUE**

   However, a string of recent surveys indicate that this number could be much higher. One project discovered that 14% of children in this age group were obese.

4. **FALSE**

   Although obese children do not suffer huge health problems while in childhood, with the exception of those caused by the overloading of joints, being obese greatly increase the risk of developing coronary heart disease.

5. **TRUE**

   The result is more brittle and fragile bones and an increased risk of fractures of the hip, spine, wrist, and limbs. These fractures can be painful and debilitating enough to lead to death. Osteoporosis can result from in inadequate accumulation of bone tissue during growth and maturation, excessive bone loss later in life, or both. Heredity and lifestyle factors can both play a role in the onset of osteoporosis.

6. **FALSE**

   Twenty percent of its sufferers are men.

7. **FALSE**

   Osteoporosis occurs earlier and in a more severe form in white and Asian women who are relatively thin and small-boned. It is more common among those who smoke and have sedentary lifestyles. Also at a higher risk are those who are deficient in vitamin D, calcium or magnesium; heavy meat eaters; and those who consume large amounts of alcohol. Risk increases with age because bones become more dense and weaker as a person grows older.

8. **FALSE**

   A healthy diet throughout life with an adequate supply of calcium is essential. Good sources of calcium include low-fat dairy products, dark-green leafy vegetables, sardines and salmon eaten with the bones, tofu, almonds and calcium-fortified foods such as orange juice, cereals and other grain products. A calcium supplement may be required, as well as vitamin D.

9. **TRUE**

10. **TRUE**

    It is found that these women who already had bones that were less dense than normal lost more bone strength than average during pregnancy—possibly putting them at a greater risk of developing osteoporosis after menopause

11. **FALSE**

    Ninety percent of the bodies' supply of vitamin D is made by the skin when it is exposed to sunlight. The remaining ten percent is obtained through foods such as sardines, salmon, and fortified milk. The nutrient makes calcium and phosphorous more available for bone mineralization. In fact, the body cannot absorb sufficient amounts of calcium without vitamin D.

12. **TRUE**

    Vitamin D is also needed to maintain strong, disease-resistant teeth as well jawbones that hold the teeth strong and healthy.

13. **FALSE**

    Older adults are more likely to be deficient in vitamin D because the body's mechanism for producing the nutrient declines with age.

14. **TRUE**

    Even people taking the recommended vitamin dosage did not obtain enough vitamin D because their skin did not synthesize an adequate amount of the vitamin.

15. **TRUE**

Lesson: Forces/Vectors and Free Body Diagrams

Social Issue: Heavily weighted backpacks cause back pain and bad posture, leading to problems in adulthood and often times aggravating scoliosis (1/10 adolescents have this medical condition). May lead to wearing a brace or even surgery in some cases.

Question: So how do backpacks cause all these problems?

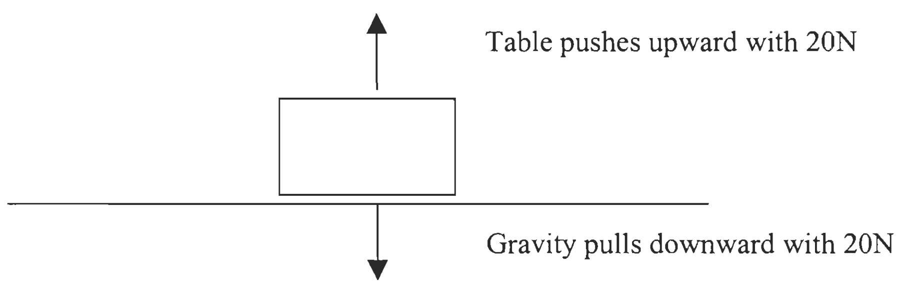
Forces exerted on muscles and bones by the weight of the backpack cause back pain and bad posture to result.

Forces: So, what are forces?

- A force is a push or pull upon an object resulting from the object's interaction with another object. Force is a vector (magnitude and direction) quantity as opposed to scalar quantities (only magnitude). An example of a force is , whereas a scalar quantity would be temperature. Ask class for more examples of force and scalar quantities:

Forces	Scalar
Velocity, acceleration,	Temperature, length, volume, speed

Since force is a vector quantity, it is represented by an arrow on a diagram, with the size of the arrow representing the magnitude of the force and the direction of the arrow representing the direction of the force. Since forces are vectors, the influence of an individual force upon an object is often canceled by the influence of another force. Observe:



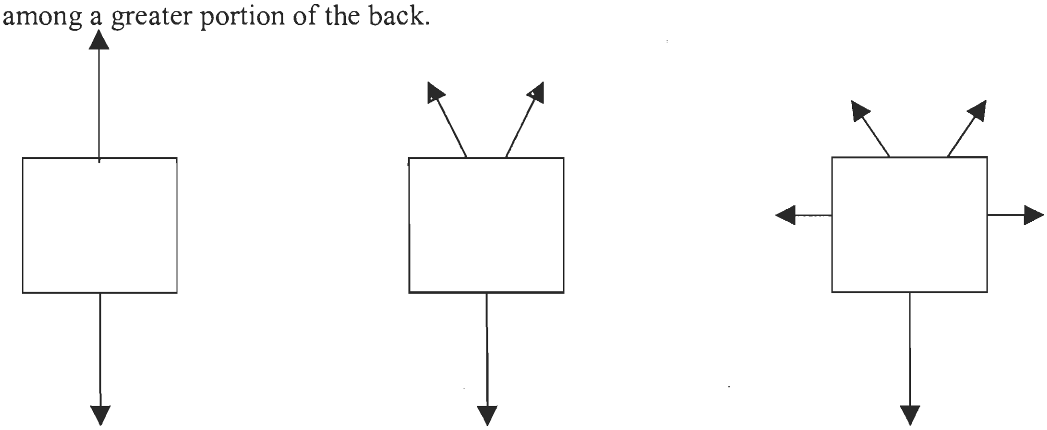
Thus, the object stays stationary or continues to move at a constant velocity since the forces cancel. If the forces didn't cancel, the object would move in the direction of the greater force.

- There are two types of forces:
  a.) Contact forces: two interacting objects physically touch one another. Examples include frictional forces, tensional forces, normal forces, air resistance forces and applied forces.
  Applied Force: applied to an object by a person or another object.
  Normal Force: Support force exerted upon an object which is in contact with another stable object. For example in the above diagram, the desk is exerting an upward force on the book in order to support the weight of the book.
  Friction Force: The force exerted by a surface as an object moves across it or makes an effort to move past it. It is equal to a frictional constant of the object * normal force.
  b.) Action-at-a-distance forces: Two interacting objects are not in physical contact with each other, yet exert a push or a pull despite physical sensation. Example is gravitational forces, electric, and magnetic forces.
  Gravitational Force: force at which earth, moon, or other massively large object attracts another object towards itself. It is the weight of the object, mass * gravity.

- Divide into groups of 2 and give them the following situations from which they must draw free body diagrams. After working on the problems below, have them come to the board and explain how they arrived at the answer:

a.) A girl is suspended motionless from a bar which hangs from the ceiling by two ropes.
b.) An egg is free-falling from a nest in a tree. Neglect air resistance, draw forces as egg is falling.
c.) A flying squirrel is gliding (no wings flapping) from a tree to the ground at constant velocity. Consider air resistance.
d.) A rightward force is applied to a book in order to move it across a desk with rightward acceleration. Consider frictional forces and neglect air resistance.
e.) A rightward force is applied to a book in order to move it across a desk at constant velocity. Consider frictional forces. Neglect air resistance.
f.) A student rests a backpack upon his shoulder. The pack is suspended motionless by one strap from one shoulder.
g.) A student rests a backpack upon his shoulder. The pack is suspended motionless by two straps on two shoulders.
h.) A skydiver is descending with a constant velocity. Consider air resistance.
i.) A force is applied to the right to drag a sled across loosely packed snow with rightward acceleration.
j.) A football is moving upwards toward its peak after having been booted by the punter.
k.) A car is coasting to the right and slowing down. Diagram the forces acting upon the car.

- In class activity of drawing force diagrams of a person wearing backpack on one shoulder, two shoulders, and two shoulders and a waist strap. Explain how the latter causes least amount of stress on back by distributing same amount of force as other two diagrams but among a greater portion of the back.



Nutritional Lesson Outline

I. Recommended Guidelines

A. Have the students fill out a sheet of everything they ate the day before

B. Explain the recommended daily allowances for specific vitamins and minerals and how they are obtained

C. Show how students can calculate how much of the recommended vitamins and minerals they obtained

1. each student calculates their actual daily allowance, focusing on calcium and vitamin D
2. each student enters their data into a class chart
3. we briefly discuss the results

II. Role of Calcium and Vitamin D in Bone Health

A. Explain how bones are formed and the structure of bones

1. Biological/ anatomical formation
2. structure of the vertebrae and surrounding muscles and how they work together??

B. Role of calcium and vitamin D in healthy bone formation

C. Show pictures of various ailments of the bones

1. see if students can guess the ailment
2. or the cause of these ailments

Nutrition Lesson

Some basic facts about your bones and vitamin D

Most people think of their bones and teeth as physically stable and permanent structures of their bodies. However, bones are in fact very dynamic. They are composed of several types of cells that coexist in a constant equilibrium between two conflicting processes - one that causes bone material to break down or resorb, and another that replaces it. This remodeling operation requires our bodies to have a sufficient and reliable supply of minerals such as calcium and phosphorus for strong bone reformation to occur. We now know that vitamin D is absolutely necessary for the efficient absorption of calcium and phosphate from our diet, as well as their normal metabolism once in the body. In addition to this well characterized function, vitamin D has been implicated as playing an important role in a wide variety of actions elsewhere in our physiology.

How does vitamin D work?

Exactly how vitamin D controls our mineral metabolism is a very active area of research. However, there are three classical target tissues for its biological actions: intestine, bone, and kidney. In the intestines vitamin D works primarily to stimulate active calcium absorption from our diet, as opposed to a passive absorption driven solely by calcium concentration. Without this potent role contributed by vitamin D, calcium serum levels would be seriously compromised. In bone, the principal effects appear to be a byproduct of vitamin D's actions on the intestine. Increased availability of minerals for incorporation into bone is the essential benefit deriving from vitamin D. However, vitamin D has also been shown to play an important part in regulating the proliferation and differentiation of both types of bone remodeling cells – those responsible for bone breakdown and those that reform the bone anew.

Kidneys represent the third prominent tissue affected by vitamin D. The most important actions of vitamin D here appear to reside in its ability to enhance reabsorption of calcium and other minerals from the renal fluid. As bones are being remodeled on a continual basis, there is a constant release or mobilization of calcium stores from these sites – and the kidneys aid in retaining the minerals for recycling back to bone. Interestingly, vitamin D acts on the kidneys in another significant way. It actually regulates its own production by feeding back and inhibiting the enzymes responsible for the production of active vitamin D.

Vitamin D – What is it? Where does it come from?

Vitamin D is actually not a vitamin. The name is a misnomer from earlier in the century when the original experiments characterizing its functions and chemistry were first described. Now it is generally classified as belonging to the hormone class of biological response modifiers. In fact, the chemistry of vitamin D is not a simple one. It enters our bodies in two primary forms, derived from two very different sources. The most abundant form cholecalciferol or vitamin D3 is obtained primarily through synthesis by ultra-violet light (UVB) in the skin, from where it then translocates into our circulation. Consequently, though many people aren't aware of it, most of our physiological requirements for vitamin D are provided for by casual exposure to sunlight. Other natural sources for cholecalciferol are few, but include egg yolks, fatty fish such as salmon, and fatty fish oils including cod liver oil. The other form ergocalciferol or vitamin D2 is principally acquired by vegetable dietary intake. However, even when combined, these natural food sources contribute only a fairly small percentage of our nutritional needs. These days, most of the vitamin D from our diets derives from vitamin D supplemented foods including milk, cereals, and breads. However, a normal adult diet has been estimated to result in the intake of less than 100 IU/day, while recommended daily allowances are at least 200 IU/day or considerably more for pregnant women and children (400 IU/day).

Factors Influencing Vitamin D Levels in Blood

A number of factors have been found to affect the levels of vitamin D in the blood, with most relating to the cutaneous synthesis of vitamin D3. Among these are latitude of location, time of day, season, race or skin pigmentation, use of sunscreens, age and dietary intake. Latitude of location can dramatically affect the production of vitamin D3 in the skin. Individuals living in produce little or none during the winter months from November to February, while farther north in Edmonton, Canada, this period is extended from October to March. Stores of vitamin D produced during the summer months will become liberated from their fat reservoirs and used during these times, but it is frequently found that the elderly or housebound suffering from insufficient stores to maintain their calcium homeostasis. Melanin content of skin or the routine use of sunscreens can cause similar vitamin insufficiencies since they absorb UVB radiation and prevent its utilization by the skin for synthesis. A simple SPF factor #8 can reduce the efficiency of synthesis by 95%. Increasing age also creates a significant problem for maintaining adequate levels of vitamin D. The skin stores less vitamin D precursor molecules as we get older, and we are less efficient at properly using what we do have – resulting in a decrease in production.

Vitamin D Deficiency – Truth or Consequences

So, what happens when vitamin D deficiencies do occur? The consequences can be quite serious. Vitamin D deficiencies have been linked with gross abnormalities in bone metabolism such as those seen in rickets, osteomalacia, and osteoporosis. As the body depletes its stores of vitamin D, intestinal calcium absorption decreases from approximately 30%-40% to no more than 15%. This induces a cascade of physiological events. For example, the lowered serum calcium concentration stimulates the production of parathyroid hormone which stimulates the bone resorbing cells to increase their activity to bring the serum concentrations of calcium back up to normal. Adequate calcium is no longer available for mineralization of new bone, and substantial bone loss may result. The end result is chronic pain, increased risk of both vertebral and nonvertebral fractures, and concomitant morbidity.

Food Sources

Animal products constitute the bulk source of vitamin D that occurs naturally in unfortified foods. Salt water fish such as herring, salmon, sardines, and fish liver oils are good sources of vitamin D3. Small quantities of vitamin D3 are also derived from eggs, veal, beef, butter, and vegetable oils. Meanwhile plants, fruits, and nuts are extremely poor sources of vitamin D. In the United States, artificial fortification of foods such as milk (both fresh and evaporated), margarine and butter, cereals, and chocolate mixes helps in meeting the RDA recommendations.

RECOMMENDED DAILY ALLOWANCES (RDA) FOR ADULTS 1995

Nutrients	Men (19~64 yrs)	Men (+64 yrs.)	Women (19~54 yrs.)	Women (+54 yrs.)
Vitamin A (microgms)	750	750	750	750
Thiamine (mg)	1.1	0.9	0.8	0.7
Riboflavin (mg)	1.7	1.5	1.2	1.0
Niacin (mg)	20	17	14	12
Vitamin B6 (mg)	2	1.5	1.4	1.1
Folate (mg)	200	200	200	200
Vitamin B12 (mg)	2	2	2	2
Vitamin C (mg)	40	40	50	50
Vitamin E (mg)	10	10	7	7
Zinc (mg)	12	12	12	12
Iron (mg)	7	7	12.6	5.7
Magnesium (mg)	320	320	270	270
Iodine (mg)	150	150	120	120

Calcium (mg)	800	800	800	1000
Phosphorus (mg)	1000	1000	1000	1000
Selenium (mmol)	70	85	85	75
Sodium (mmol)	40-100	40-100	40-100	40-100
Potassium (mmol)	50-140	50-140	50-140	50-140

HOW MUCH IS 'ONE SERVING'?

MILK & MILK PRODUCTS GROUP 1 cup (8 oz.) milk or yogurt
2 slices cheese, 1/8" thick (1½ oz.)
2 cups cottage cheese
1½ cups ice milk, ice cream, or frozen yogurt

MEAT & MEAT ALTERNATIVES GROUP 2 oz. To 3 oz. (size of a deck of cards) cooked *lean* meat, poultry, or fish
2 eggs
7 oz. Tofu
1 cup cooked legumes (dried beans or peas)
4 tablespoons peanut butter
1/2 cup nuts or seeds

VEGETABLE GROUP 1/2 cup cooked vegetables
1/2 cup raw chopped vegetables
1 cup raw leafy vegetables
1/2 to 3/4 cup vegetable juice

FRUIT GROUP 1 whole medium fruit (about 1 cup)
1/4 cup dried fruit
1/2 cup canned fruit
1/2 to 3/4 cup fruit juice

BREAD & CEREAL GROUP 1 slice bread
1 medium muffin
1/2 hot dog bun or hamburger bun
1/2 bagel or english muffin
4 small crackers
1 tortilla
1 cup cold cereal
1/2 cup cooked cereal
1/2 cup rice
1/2 cup pasta

Comparing the RDA to the food sources of calcium helps to put the RDA in perspective:

- 8-ounce glass of milk = 300 milligrams
- 2 ounces of Swiss cheese = 530 milligrams
- 6 ounces of yogurt = 300 milligrams
- 2 ounces of sardines with bones = 240 milligrams
- 6 ounces of cooked turnip greens = 220 milligrams
- 3 ounces of almonds = 210 milligrams

A total intake of up to 2,000 milligrams per day from dietary sources and supplements appears to be safe. The preferred source of calcium is calcium-rich foods such as dairy products.

ASSIGNMENT

For homework record the estimated or calculated (can be found on the food label and is either an amount or a percent) value of Vitamin D and Calcium in all of the food you ate during a 24 hour period below. In class we will record the data from every student and analyze whether the class as a whole or each individual is getting an adequate source of these nutrients. You will then propose possible solutions or recommendations as a group.

Breakfast:

FOOD	AMOUNT OF VITAMIN D	AMOUNT OF CALCIUM

Lunch:

FOOD	AMOUNT OF VITAMIN D	AMOUNT OF CALCIUM

Dinner:

FOOD	AMOUNT OF VITAMIN D	AMOUNT OF CALCIUM

Snacks:

FOOD	AMOUNT OF VITAMIN D	AMOUNT OF CALCIUM

Experimental Design Lesson

- An experiment is defined as any study in which treatments are imposed on experimental units in order to observe responses is an experiment.
- The type of experiment that is being done with the questionnaires is a sampling study. Sampling studies is a study in which a sample (subset of the larger target population) is drawn from a target population (collection of sampling units about which we want to draw conclusions), and the responses observed from the sample are used to draw conclusions about the target population. A sampling unit is an entry on which a single measurement or observation, called a response, can be made.

Pass out attached questions for short in class exercise.

For each of the sampling studies described below, identify the sampling unit, response, target population, and sample.

Question: A cable television company wants to measure the satisfaction of its customers. To do so, it mails questionnaire to 800 selected households by asking if overall is the customer satisfied with the cable service provided. Assume that all 800 households return the questionnaire.
Answers:
Sampling Unit: Household

Response: Answer to question "Overall, are you satisfied with the cable service we provide."

Target Population: All subscribing households.

Sample: 800 households returning the questionnaire.

Question: Ecologists frequently measure wildlife populations. In one study to estimate the number of deer in a certain region, the region is divided into 1000 small "tracts" , and 50 tracts are chosen for observation. In each of the selected tracts, ecologists try to obtain a complete enumeration of deer.
Answers:
Sampling Unit: Tract

Response: Count of deer in a tract.

Target Population: All tracts in the region.

Sample: 50 chosen tracts.

- Sampling Methods: Mechanisms based on chance allow us to statistically characterize the accuracy and precision of the results.

a.) Simple random sampling is a probability sampling method in which each sample has the same chance of being chosen.
b.) Stratified random sampling involves sampling within strata of the population. Strata are subgroups of individuals which are similar in some way in the sample population.

- In sampling studies, sample data is used to draw conclusions about the target population. Since the sample is not an exact image of the population, conclusions obtained from the sample won't exactly match the true state of the population. This is called a sampling error.

Non sampling errors are errors that result from the inability to conduct a sampling study correctly. Three sources of nonsampling errors are:
a.) selection bias- excludes one or more kinds of sampling unit from the sample. Sampling study of households will miss homeless, prison inmates, and students in dormitories.
b.) nonresponse bias- happens in studies involving human populations when a selected individual cannot be contacted or refuse to cooperate. There the achieved sample size will be smaller than the planned sample size and the population that is sampled is not the target population but rather a population of those willing to respond. A telephone survey firm that calls only during evening hours will fail to contact single individuals who work at night.
c.) Response bias- happens in studies involving human populations when questions are phrased in a manner which is difficult to understand, or a "leading" question.

Question: In 1936 Roosevelt-Landon were competing in the U.S. presidential election. Polls were taken using phone books and car registration. Polls supported Landon winning by a landslide, but exactly the opposite happened. Why do you think this is so?

Answer: Because in 1936 not all people had telephones and cars, only the rich had them. The sample was grossly misrepresentative of the American population.

Pass out bias worksheets seen below and have students answer them in class then discuss.

There are potential biases associated with each of the sampling schemes described below. Describe what they are and how you expect them to affect the results. What, if anything, can be done to obtain better results?

a.) In an interview of heads of families with both husband and wife present, the interviewer asks how many sex partners each had in the past year.
  a.) People will lie with their spouses present
b.) The U.S. Census Bureau tries to estimate the number of illegal aliens in the country by sending out interviewers to go door to door.
  a.) People will not admit that they are in the country illegally.
  b.) People may be at work at the time the interviewers go out.

c.) Illegal aliens cannot necessarily speak/understand English to answer questions.

c.) To gauge public sentiment on gun control, a TV news show has viewers call a 900 number during the 11 o'clock newscast. The question to be answered is "Should the government infringe on our constitutional right to bear arms?"

a.) Leading question

b.) Many people who go to work are asleep by 11

c.) 900 numbers cost money.

Mini-Project

Purpose:

The purpose of this mini-project is to give you experience in the design, conduct, and analysis of a sampling experiment.

Process:

Your group is to design, conduct, and analyze an experiment comparing any two variables (for example surveying people to ask whether they like pepsi or coke).

You are required to submit a short (less than one page) proposal before conducting the experiment. The proposal must state at the outset the question or questions you propose to investigate. You must describe the design of the experiment carefully and you should state clearly how you are going to collect the data. State what factors that you are going to consider, how you are going to measure the responses, who your subjects are and what characteristics your subject might have that can help in assessing any differences between your two variables.

For each of the sampling studies described below, identify the sampling unit, response, target population, and sample.

Question: A cable television company wants to measure the satisfaction of its customers. To do so, it mails questionnaire to 800 selected households by asking if overall is the customer satisfied with the cable service provided. Assume that all 800 households return the questionnaire.

Sampling Unit:

Response:

Target Population:

Sample:

Question: Ecologists frequently measure wildlife populations. In one study to estimate the number of deer in a certain region, the region is divided into 1000 small "tracts" , and 50 tracts are chosen for observation. In each of the selected tracts, ecologists try to obtain a complete enumeration of deer.

Sampling Unit:

Response:

Target Population:

Sample:

There are potential biases associated with each of the sampling schemes described below. Describe what they are and how you expect them to affect the results. What, if anything, can be done to obtain better results?

d.) In an interview of heads of families with both husband and wife present, the interviewer asks how many sex partners each had in the past year.

e.) The U.S. Census Bureau tries to estimate the number of illegal aliens in the country by sending out interviewers to go door to door.

f.) To gauge public sentiment on gun control, a TV news show has viewers call a 900 number during the 11 o'clock newscast. The question to be answered is "Should the government infringe on our constitutional right to bear arms?"

Ratios and Percents

Ratios

At a school there are 35 teachers and 525 students. We can compare the number of teachers to students by writing a quotient.

$$\frac{\text{number of teachers}}{\text{number of students}} = \frac{35}{525}\text{, or } \frac{1}{15}$$

The indicated quotient of one number divided by a second number is called the ratio of the first number to the second number. We can write the ratio in the following ways:

1/15   1:15   1 to 15

All of these expressions are read *one to fifteen*. If the colon notation is used, the first number is divided by the second. A ratio is said to be in **lowest terms** if the two numbers are relatively prime. You do not change an improper fraction to a mixed number if it represents a ratio.

Example One:

There are 9 players on a baseball team. Four of these are infielders and 3 are outfielders. Find each ratio in lowest terms.

a. infielder to outfielders

b. outfielders to total players

Solution:

a. $\frac{\text{infielders}}{\text{outfielders}} = \frac{4}{3}$, or 4:3, or 4 to 3

b. $\frac{\text{outfielders}}{\text{total players}} = \frac{3}{9} = \frac{1}{3}$, or 1:3, or 1 to 3

Some ratios compare measurements. In these cases, we must be sure that the measurements are expressed in the same unit.

Example Two:

It takes John 4 minutes to mix some paint. He can paint a room in 3 hours. What is the ratio of the time it takes John to mix the paint to the time it takes him to paint the room?

Solution:

3 h = 3 * 60 min = 180 min

The ratio is $\frac{\text{min to mix}}{\text{min to paint}} = \frac{4}{180} = \frac{1}{45}$, or 1:45

Class Exercises

Express each ratio as a fraction in lowest terms.

a. 5 to 7 b. 11 to 6 c. 10:30 d. 12:24 e. 8 to 2

f. 32 to 4 g. 68:17 h. 45:18

Rewrite each ratio so that the numerator and denominator are expressed in the same unit of measure.

a. (2 dollars)/(50 cents) b. (5 months)/(2 years)

c. (35 cm)/ (1 m) d. (12 min.)/ (2 h.)

Percents and Fractions

During basketball season, Mary made 17 out of 25 free throws, while Kathy made 7 out of 10. To see who did better, we compare the fractions representing each girl's successful free throws:

17/25 and 7/10

In comparing fractions it is often convenient to use the common denominator 100, even if 100 is not the **LCD** of the fractions.

17/25 = (17*4) / (25*4) = 68/100

7/10 = (7*10) / (10*10) = 70/100

Since Mary makes 68 free throws per hundred and Kathy makes 70 per hundred, Kathy is the better free-throw shooter.

The ratio of a number to 100 is called a **percent**. We write percents by using the symbol **%**. For example,

17/25 = 68/100 = 68% and

7/10 = 70/100 = 70%

> **RULE**
> To express the fraction a/b as a percent, solve the equation n/100 = a/b for the variable n and write n%.

Example One:

Express 17/40 as a percent.

Solution:

n/100 = 17/40

Cross-multiply.

40*n = 17*100

n = 17/40 *100 = 85/2 = 42 ½ = 42 ½% or 42.5%

Example Two:

Express 7 ½% as a fraction in lowest terms.

Solution:

7 ½% = 7.5%= 7.5/100 = (7.5*10)/(100*10) = 75/1000 = 3/40

Example Three:

Write 250% as a mixed number in simple form.

Solution:

250% = 250/100

= 2 50/100 = 2 ½

Example Four:

A certain town spends 42% of its budget on education. What percent is used for other purposes?

Solution:

The whole budget is represented by 100%. Therefore, the part used for other purposes is:

100-42, or 58%

Class Exercises:

Express as a fraction in lowest terms or as a mixed number in simple form.

1. 17%	2. 90%	3. 50%	4. 25%	5. 20%
6. 100%	7. 4%	8. 150%	9. 300%	10. 30%
11. 35%	12. 210%			

Express as a percent.

a. 1/50	b. 1/10	c. 7/10	d. 1	e. 2
f. 1/20	g. 3 ½	h. 9/10	i. ¾	j. 4 ½

k. 2/25 l. 3/20

Statistical Analysis Lesson

I. Types of Data

1. quantitative
   a. continuous (blood pressure, height, weight, age)
   b. discrete (number of children, number of asthma attacks per week)
2. qualitative/ categorical
   a. ordinal (ordered categories)
      - exam results
      - socio-economic status
   b. nominal (unordered categories)
      - sex (male/female)
      - eye color

II. Variables

A. dependent vs. independent
   1. dependent-- only measured or recorded; depend on the manipulation or "what the subject will do in response"; **traditionally the Y value**
   2. independent-- variables that are manipulated; **traditionally the X value**

B. measurement scales
   1. nominal variables
      - allow for only qualitative classification; they can be measured only in terms of whether the individual items belong to some distinctively different categories, but we cannot quantify or even rank these categories
      - example—we can say that two individuals are different in terms of variable A, but we cannot say which has more of the "quality" than the other (gender, race, color ,city, etc.)
   2. ordinal variables
      - allow us to rank order the items we measure in terms of which has less and which has more of the quantity represented by the variable, but still they do not allow us to say "how much more"
      - example—socioeconomic status of families, we know that upper-middle is higher than middle but we cannot say that it is, for example, 18% higher
   3. interval variables

- allow us to not only to rank order the items that are measured, but also to quantify and compare the sizes of differences between them
- example—temperature, as measured in degrees Fahrenheit or Celsius, is an interval scale. We can say that a temperature of 40 degrees is higher than a temperature of 30 degrees, and that an increase from 20 to 40 degrees is twice as much as an increase from 30 to 40 degrees

4. ratio scale
   - very similar to interval variables
   - in addition to all of the properties of interval variables, they feature an identifiable absolute zero point, thus they allow for statements such as **x is two times more than y**
   - example—Kelvin temperature scale. Not only can we say that a temperature of 200 degrees is higher than 100 degrees, we can correctly state that it is twice as high

III. Statistical Significance

A. definition—the probability that the observed relationship or difference in a sample occurred by pure chance, and that in the population from which the sample was drawn, no such relationships or differences exist

B. determination—arbitrary
   1. for larger data samples probability of relationship can be lower due to the sheer number of the sample
   2. for small data samples probability of relationship must be high in order to receive statistical significance because a change in a few data points can change the relationship between the entire data sample

C. correlation coefficients—relationship between variables
   1. the closer the coefficient is to one or negative one the stronger the relationship
   2. the closer the coefficient is to one the weaker the relationship
   3. ideally the correlation coefficient should be greater than 0.95 or less than –0.95

D. size of sample
   1. the more analyses one performs on a data set, the more results will meet "by chance" the conventional significance level
   2. if there are very few observations then there are also respectively few possible combinations of the values of the variables, and thus the probability of obtaining

by chance a combination of those values indicative of a strong relation is relatively high

E. "baby boys to baby girls ratio

There are two hospitals: in the first one, 120 babies are born every day, in the other, only 12. On average, the ratio of baby boys to baby girls born every day in each hospital is 50/50. However, one day, in one of those hospitals twice as many baby girls were born as baby boys. **In which hospital was it more likely to happen? Why?**

F. Calculations

1. magnitude—strength
2. median—middle value
3. mode—most common value
4. variation/ deviation—grouping of the data
   - a low variation means that the data points are grouped closely together
   - susceptible to outliers, points well outside the main body of the data

IV. Normal Distributions

A. Characteristics

1. a bell-shaped curve
2. symmetric about the mean

B. Introduced by French mathematician Abraham de Moivre in 1733

C. Examples

1. height of a man
2. the velocity in any direction of a molecule in gas
3. the error made in measuring a physical quantity

V. Data Display

A. dot plot (simplest way)

B. box-whisker plot (alternative to the dot plot when data sets are large)

C. histograms (distribution of a continuous variable, there should be no gaps between the bars)

D. bar charts (shows the distribution of a discrete of categorical variable, there should be gaps in between the bars)

Statistical Analysis on a TI Graphic Calculator

A. Entering in the data
1. Push the **STAT** button on the calculator
2. Go to **EDIT**
3. Enter the dependent variable values into **L1** and the independent variable values into **L2**

B. Graphing the data points
1. Go to **STAT PLOT** by pushing the button **2nd** and then the button **Y=**
2. Push **ENTER** on **PLOT1**
3. Turn on the plot by pushing **ENTER** on **ON**
4. Pick the type of graph by pushing **ENTER** on the selected type
5. Pick the X and Y axis by entering the list number. It should be **L1** for the **Xlist** and **L2** for the **Ylist**. If these values are not already entered into the calculator you can change them by pushing the button **2nd** and the finding **L1** and **L2**. They should be buttons **1** and **2**. But each calculator may be different.
6. Select the desired type of mark by pushing **ENTER**
7. Check to see if all of the other plots are turned off
8. Push the **ZOOM** button and then push **9** or go down to **ZoomStat** and push enter. This should graph your data points.

C. Finding the line of best fit
1. To display the correlation coefficient **r** or the coefficient of determination r^2 or R^2 push the buttons **2nd** and **0**. Go down to **DiagnosticOn** and push **ENTER** twice. The screen should say

   DiagnosticOn

   Done
2. Hit **STAT** and go over to **CALC**.
3. Perform the following tests:
   a. **LinReg(ax+b)**
   b. **Lin(a+bx)**
   c. **LnReg**
   d. **ExpReg**
   e. **PwrReg**
   f. **QuadReg**
   g. **CubicReg**
   h. **QuartReg**
4. Perform the tests by entering on the chosen test and hitting **L1** and **,** and **L2**.
5. The line of best fit will be determined by the correlation coefficient and/or the coefficient of determination. Which ever test gives values closest to one is the winner.
6. To graph the line of best fit hit the buttons:
   a. **Y=** and go to **Y1** (make sure there are no equations entered into any of the y values)
   b. **VARS**
   c. **5**
   d. go over to **EQ** and hit **ENTER**
   e. **GRAPH**

Statistical Exercise

Plot the points and determine the line of best fit using the correlation coefficient or the coefficient of determination as measures.

(1)

L1 Values	L2 Values
1	8
5	60
7	101
9	232
11	227
12	417
15	650
20	1167

(2)

L1 Values	L2 Values
1	3.4
5	28.397
7	78.0677
9	239.1757
11	685.4379
12	1165.2445
15	5726.8461
20	81284.6281

(3)

L1 Values	L2 Values
1	10
5	23
7	54
9	80
11	121
12	140
15	225
20	380

(4)

L1 Values	L2 Values
1	15
5	18.2189
7	18.8918
9	19.2944
11	19.7958
12	19.9698
15	20.4161
20	20.9915

Finding the Equation of a Line

The Slope-Intercept Equation

If we can determine the slope and y-intercept of a line, we can use the slope-intercept equation, **$y = mx + b$**, to write an equation of the line.

Example One

Write an equation for the line with slope 2 that contains the point (3, 1).

Use the given point (3,1) and substitute 3 for x and 1 for y in $y = mx + b$. Substitute 2 for m, the slope. Then solve for b.

$y = mx + b$

$1 = 2(3) + b$

$-5 = b$

We can substitute 2 for m and –5 for b in $y = mx + b$ to get the answer of **$y = 2x-5$.**

Class Exercises

Write an equation for the line that contains the given point and has the given slope.

a. (4, 2), $m= 5$ b. (-2, 1), $m= -3$

Example 2

Write an equation for the line containing (1, 3) and (-2, 3).

$$m = \frac{\text{change in } y}{\text{change in } x} = \frac{-3 - 3}{-2 - 1} = \frac{-6}{-3} = 2$$

Choose either point and substitute for x and y in $y = mx + b$. Also substitute 2 for m, the slope. Then solve for b.

$y = mx + b$

$3 = 2(1) = b$

$1 = b$

Substitute 2 for m and 1 for b in $y = mx +b$, giving the final answer of **$y = 2x +1$**.

Class Exercises

Write an equation for the line that contains the given two points.

c. (8, 2) (2, 6) d. (-1, 4) (-3, -5)

The Point-Slope Equation

Return to Example One. We know that the line contains the point (1, 3). Let (x, y) represent any point on this line. We can use the definition of the slope to write the following:

$$m = \frac{\text{difference of } y\text{-coordinates}}{\text{difference of } x\text{-coordinates}} = \frac{y - 3}{x - 1}$$

We know the slope is 2. Thus we can write:

$$2 = \frac{y - 3}{x - 1} \text{ or } \frac{y - 3}{x - 1} = 2$$

If we multiply both sides by $(x - 1)$, we have:

$$y - 3 + 2(x - 1) \text{ or } y = 2x + 1$$

This last equation is satisfied by every point on the line and is the equation for the line.

For the point (1, 3) and slope 2, we develop the equation above.

$y - 3$	$=$	2	$*$	$(x - 1)$
y-coordinate		slope		x-coordinate

The Point-Slope Equation

A nonvertical line with slope m and containing a point (x_1, y_1) has an equation:

$$y - y_1 = m(x - x_1)$$

Example Three

Write an equation for the line with slope 3 that contains the point (5, 2). Express the equation in slope-intercept form.

$$y - y_1 = m(x - x_1)$$

$$y - 2 = 3(x - 5)$$

$$y - 2 = 3x - 15$$

$$y = 3x - 13$$

Class Exercises

Write an equation for each line with the given point and slope. Express the equation in slope- intercept form.

e. (3, 5), $m = 6$ f. (1, 4), $m = -2/3$

Appendix F
Pre-Questionnaire to Determine Attitudes toward Subjects

North High School

Grade 9 Pre-Course Survey

1.) What is your name? ____

2.) Are you
a.) Male ____________ b.) Female ____________

3.) What is your age? ______________

4.) Do you live
a.) in a city b.) near a city (suburb) c.) in a rural area

5.) What is your father's occupation? _______________________________________

6.) What is your mother's occupation? _______________________________________

7.) What do you expect your occupation to be when you are your parents' age?

____

8.) Rank you liking of the following subjects on a scale of 1 to 10, 1 being the lowest, and 10 being the highest:

a.) English (writing, spelling) __________
b.) Mathematics __________
c.) Life Science (biology) __________
d.) Physical Science (chemistry, physics) __________
e.) Health Sciences __________
f.) Social Studies __________
g.) Reading, Literature __________
h.) Computer Science __________
i.) Art/Drama/Dance __________
j.) Other (please specify) __________
____

9.) How much are you enjoying your science class?

not at all	not much	about average	quite a bit	very much
1	2	3	4	5

10.) How much are you enjoying your health class?

not at all	not much	about average	quite a bit	very much
1	2	3	4	5

11.) How often do you learn about new things in your science class?

not at all	not much	about average	quite often	very often
1	2	3	4	5

12.) How often do you learn about new things in your health class?

not at all	not much	about average	quite often	very often
1	2	3	4	5

13.) How much effort do you need to put forth in your science class to get an A?

none at all	not much	about average	quite a bit	very much
1	2	3	4	5

14.) How much effort do you need to put forth in your health class to get an A?

none at all	not much	about average	quite a bit	very much
1	2	3	4	5

15.) How much effort are you putting into your science class now?

none at all	not much	about average	quite a bit	very much
1	2	3	4	5

16.) How much effort are you putting into your health class now?

none at all	not much	about average	quite a bit	very much
1	2	3	4	5

17.) Do you expect to do well in your science class now?

No, not very well	below average	average	above average	yes, very well
1	2	3	4	5

18.) Do you expect to do well in your health class now?

No, not very well	below average	average	above average	yes, very well
1	2	3	4	5

19.) How important will the information you learn in your science class be to your life?

not at all important	very important	somewhat important	important	very important
1	2	3	4	5

20.) How important will the information you learn in your health class be to your life?

not at all important	very important	somewhat important	important	very important
1	2	3	4	5

21.) How important will the information you learn in your science class be to your future schoolwork?

not at all important	very important	somewhat important	important	very important
1	2	3	4	5

22.) How important will the information you learn in your health class be to your future schoolwork?

not at all important	very important	somewhat important	important	very important
1	2	3	4	5

23.) If it were up to you, would you spend more or less time studying the topic you are currently covering in your science class?

much less time	less time	about the same time	more time	much more time
1	2	3	4	5

24.) If it were up to you, would you spend more or less time studying the topic you are currently covering in your health class?

much less time	less time	about the same time	more time	much more time
1	2	3	4	5

25.) How much more would you like to learn about the subjects covered in your science class in the future?

Nothing	not much	somewhat more	quite a bit	very much
1	2	3	4	5

26.) How much more would you like to learn about the subjects covered in your health class in the future?

Nothing	not much	somewhat more	quite a bit	very much
1	2	3	4	5

27.) Each of the following lines contains a pair of words. Select on the scale where you feel your view of science fits best:

a.) Facts	1	2	3	4	5	concepts
b.) Lively	1	2	3	4	5	boring
c.) Easy	1	2	3	4	5	hard
d.) Stable	1	2	3	4	5	challenging
e.) Traditional	1	2	3	4	5	new
f.) Experiment	1	2	3	4	5	real world

g.) Human	1	2	3	4	5	technical
h.) Competitive	1	2	3	4	5	cooperative

28.) How much confidence do you have in the people running the following organizations?

a.) The president of the U.S.	1	2	3	4	5
b.) President of Large Companies	1	2	3	4	5
c.) Leading scientists	1	2	3	4	5
d.) Television news teams	1	2	3	4	5
e.) Leader of environmental groups	1	2	3	4	5
f.) Well known teachers	1	2	3	4	5
g.) Military officers	1	2	3	4	5

29.) How smart would you have to be to understand the material taught in your science class well enough to use it in an important job?

very Smart	above average	just average	most people could do it	anyone could do it
1	2	3	4	5

30.) How smart would you have to be to understand the material taught in your health class well enough to use it in an important job?

very Smart	above average	just average	most people could do it	anyone could do it
1	2	3	4	5

31.) How likely is it that you would want a job that involved using the material from your science course?

very likely	likely	not likely	not at all likely	don't know
1	2	3	4	5

32) How likely is it that you would want a job that involved using the material from your health course?

very likely	likely	not likely	not at all likely	don't know
1	2	3	4	5

33.) How likely is it that you would do well in more advanced courses in the subject of science?

very likely	likely	not likely	not at all likely	don't know
1	2	3	4	5

34.) How likely is it that you would do well in more advanced courses in the subject of health?

very likely	likely	not likely	not at all likely	don't know
1	2	3	4	5

35.) How likely is it that you will go to college and study to become a scientist or engineer?

very likely	likely	not likely	not at all likely	don't know
1	2	3	4	5

36.) How important are the contributions of scientists to society?

very important	important	not important	not at all important	don't know
1	2	3	4	5

37.) Circle the choice that best describes your view of science.
Science is:
1.) interesting but not important
2.) important but not interesting
3.) important and interesting
4.) not important and not interesting

38.) Circle the choice that best describes your view of math.
Math is:
1.) interesting but not important
2.) important but not interesting
3.) important and interesting
4.) not important and not interesting

Please circle the number that most closely represents how much you agree or disagree with the statement.

39.) When the scientists can't agree on what is true, and what is not, the teacher should not mention that material in a course until there is an agreement.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

40.) The teacher is very confident that what we are being taught is true, and will always be true.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

41.) I believe that my teacher can always tell what is true and what is not.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

42.) Science courses should include brand new material even if that means we need to learn about two or three theories that are still being disputed.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

43.) Science helps me learn how to think more clearly.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

44.) Math help me learn how to think more clearly.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

45.) Technology often gets out of control, and lots of people are hurt directly or indirectly when this happens.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

If you agree with the above statement, can you think of an example?

____

____

46.) The scientific community can solve any problem if it is given enough time and money.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

Can you think of an example or counter example?

____

____

47.) The benefits and advantages of science and technology far outweigh the costs and disadvantages.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

48.) Place a check beside each of the following things that you think a scientist would do.

a.) ________ show feelings
b.) ________ keep feelings a secret
c.) ________ work with others
d.) ________ work steadily
e.) ________ work a while, rest, then work again
f.) ________ like stories about people and places
g.) ________ enjoy fantasy stories
h.) ________ try to be the best
i.) ________ want to know why
j.) ________ want to know what matters to people
k.) ________ enjoy surprises
l.) ________ too many changes can be stressful
m.) ________ adapt well to change
n.) ________ answer right away
o.) ________ think before answering
p.) ________ like to do what they're good at over and over again
q.) ________ like to learn how to do new things
r.) ________ like to understand others
s.) ________ like to work with others
t.) ________ like to get things done
u.) ________ like to have learning be a time for fun and adventure

Appendix G

Pre-Course Examination

Pre-Course Evaluation

The following is an evaluation of your knowledge coming into this unit, and in no way determines your grade or intelligence. It is simply a measure that we will use to track your improvement throughout this unit, and hope that you will complete is as accurately as possible. Do not be alarmed if you don't know what many of the questions are asking, as it is likely that you have not had some of the subjects that these questions are asking.

Multiple Choice:

1.) What is scoliosis?
  a.) Gastrointestinal infection
  b.) Curvature of the spine
  c.) Congenital knee defect
  d.) STD
  e.) Don't know

** If you answered a-d, please explain what you know about scoliosis in a paragraph or two. Please try and include what you feel are the long-term and short-term affects of scoliosis are.

2.) The following vitamin/nutrients are necessary for proper bone formation and growth.
a.) Calcium/Vitamin E
b.) Biotin/Vitamin D
c.) Vitamin A/Vitamin D
d.) Calcium/Vitamin D
e.) Biotin/Vitamin A

3.) Osteoporosis is least likely to affect all of the following individuals except:
a.) women past menopause
b.) middle-age men
c.) pregnant women in their 20-30's.
d.) teenagers
e.) this is a trick question, all of the above have an equal chance of getting osteoporosis

4.) The human vertebrae may be divided into the following regions:
a.) cervical, thoracic, lumbar, sacral
b.) scapula, humerus, radius, ulna
c.) scaphoid, trapezium, lunate, hamate
d.) fibula, tibia, femur, calcaneus
e.) sacrum, coccyx, acetabulum, illium

5.) The following is a muscle located in the back:
a.) sartorius
b.) lattismus dorsi
c.) gluteus maximus
d.) biceps brachii
e.) frontalis

6.) A scientific hypothesis:
a.) is considered a fact
b.) is considered a law
c.) is an educated guess
d.) is a shot in the dark
e.) is unable to be tested

7.) A researcher is testing the effects of backpack weight on the posture of students. Which of the following would be an appropriate control for this experiment?
a.) a student who is not carrying a backpack
b.) a student who is carrying an empty backpack
c.) a student is who is carrying the heaviest backpack
d.) a student who is carrying the lightest backpack
e.) a student who is carrying a backpack of average weight.

8.) All of the following are forces except:
a.) friction
b.) gravity
c.) weight
d.) magnetism
e.) mass

9.) Which of the following is a vector quantity?
a.) speed
b.) velocity
c.) temperature
d.) length
e.) volume

10.) What is an outlier?
a.) the median of your data
b.) the largest number in your data
c.) the lowest number in your data
d.) the most common number in your data
e.) data point that does not fit the general trend of the data

11.) In a certain class there are 4 freshman boys, 6 sophomore boys, 7 freshman girls, and 3 sophomore girls. What is the percentage of freshman males in the class?
a.) 36%
b.) 25%
c.) 20%
d.) 50%
e.) 40%

Essay Questions:

1.) A student who weighs 120 pounds carries a backpack that weighs 30 pounds, and usually carries the backpack on one shoulder. Please describe what you feel the long-term and short-term affects of such usage can be on the student's health.

2.) Please graph the following data points below. Draw the best fit linear line that fits the data, and find its equation.

Weight of female trout (mgs)	Number of eggs laid by trout
10.7	25
6.8	11
13.2	30
8.2	20
22.8	44
41.6	82
33.2	71
19.2	37
7.8	19
14.8	28
21.3	41
29.4	64
26.8	52
43.9	93
36.2	77

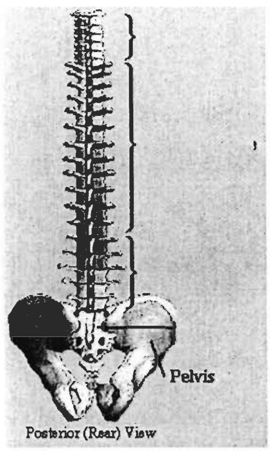
3.) What vitamins/minerals and activities are necessary for a healthy lifestyle and healthy body? Do you think that people your age are getting enough or too much of the above, why or why not? What implications does this have for the future?

Appendix H
Post-Course Examination

Final Evaluation

Name: ______________________________
Date: ______________________________

1.) List the five regions of the vertebral column described in class. List one characteristic of each of the five regions. If you can list more then one characteristic for any of the five regions bonus points will be rewarded. **(10 points)**



2.) List any three muscles in the back and briefly give there origin and/or insertion and/or function. The more information you give us for this question, the more bonus points you earn. **(10 points)**

3.) Scoliosis is a trick knee.

TRUE FALSE

If you chose false, what is scoliosis? **(5 points)**

4.) List some treatments for scoliosis, and at what level of scoliosis are these treatments advisable? **(10 points)**

5.) There is a debate between school officials concerning scoliosis. What is the cause of this disagreement, and where do you stand in this issue? Briefly support your position. **(10 points)**

6.) In terms of force diagrams, why is it better to wear your backpack on 2 shoulders rather than one shoulder? **(10 points)**

7.) Osteoporosis cannot be prevented:

TRUE FALSE

If you chose false, please explain why. **(5 points)**

8.) In Boston the sunlight from the end of October through the beginning of March is too weak for the skin to produce any Vitamin D.

TRUE FALSE

If you chose false, please explain why. **(5 points)**

9.) The two most essential vitamin/minerals for healthy bones are: **(5 points)**

a.) Vitamin C/Calcium
b.) Vitamin D/Calcium
c.) Biotin/Calcium
d.) Vitamin E/Calcium
e.) Vitamin E/Vitamin C

10.) List two of the five common exercises that physicians now recommend that you avoid and give a brief reason for why these exercises should be avoided. There will be bonus points if you can list more than two of the exercises. **(10 points)**

11.)Below you find some data that the class gathered in the backpack questionnaire. List which variable you feel is the dependent variable and which variable is the independent variable. Briefly explain how you chose which variable was which. Analyze the data in any way you feel is appropriate (percentages, bar graphs, pie graphs, charts, etc.). This is a very open-ended question and will be graded as such. **(10 points.)**

Have you experienced backpain?	Do you think backpain is a problem for students your age?
Yes	Don't Know
No	No, not a problem
No	Don't Know
Yes	Big problem
Yes	Don't Know
Yes	No, not a problem
No	Somewhat problem
Yes	Don't Know
Yes	Big problem
Yes	Big problem
No	No, not a problem
No	No, not a problem
Yes	Big problem
Yes	Don't Know
Yes	Big problem
Yes	Big problem
Yes	No, not a problem
Yes	Don't Know
Yes	Somewhat problem
No	Somewhat problem
No	Big problem
No	Don't Know
No	Big problem
No	Big problem

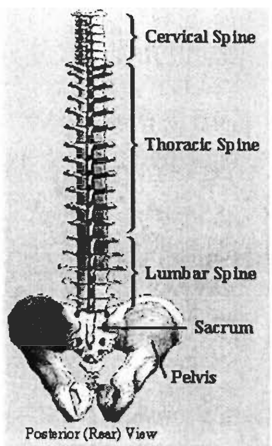
Extra Credit:

What is a Dowargers Hump?

Final Evaluation

Name: ANSWER KEY
Date: ______________________________

1.) List the five regions of the vertebral column described in class. List one characteristic of each of the five regions. If you can list more then one characteristic for any of the five regions bonus points will be rewarded. **(10 points)**



1.) Cervical- smallest of the vertebrae, densest bone tissue, 5 vertebrae make up the neck.
2.) Thoracic- vertebrae contain articular surfaces which help attach to the ribs, compose first primary curve (the curve present at birth), 12 vertebrae make up the upper back.
3.) Lumbar- bones most support the largest amount of weight, therefore are the strongest and largest, compose second secondary curve, 5 vertebrae make up the lower back.
4.) Sacrum- triangular in structure, protect internal organs, vertebrae that form base of vertebral column
5.) Coccyx- forms base of vertebral column, composed of 4 attached vertebrae, also known as tailbone.

2.) List any three muscles in the back and briefly give there origin and/or insertion and/or function. The more information you give us for this question, the more bonus points you earn. **(10 points)**

Deltoid- origin-tip of shoulder, collarbone : insertion- humerus (upper arm bone) : action- raises arm
Trapezius- origin- upper back, back and head and neck : insertion- clavicle (collarbone) to scapula : action: extends head and neck, elevates clavicle (shrugs shoulders).
Lattismus Dorsi- origin- middle of back : insertion – humerus : action- lowers arm and extends shoulder
Infraspinatus- origin- shoulder blade : insertion- humerus : action- lateral rotation of arm and stabilizes shoulder
Teres Minor- origin- posterior edge of scapula : insertion- humerus : action- lateral rotation of the humerus
Quadratus Lumborum- origin- hip : insertion- lower vertebrae (lumbar region of the spine) and adjacent surface of the ribs : action- flexes spinal column
Eractor Spinae- origin- back of head : insertion- sacrum : action- extends spinal column

3.) Scoliosis is a trick knee.

TRUE **FALSE**

If you chose false, what is scoliosis? **(5 points)**

Scoliosis is a side-to-side curvature of the spine that generally occurs in the thoracic and lumbar regions of the spine. It is most prevalent in adolescent girls between the ages of 10-18.

4.) List some treatments for scoliosis, and at what level of scoliosis are these treatments advisable? **(10 points)**

1.) **Monitoring- scoliosis may be monitored for curves up to 25 degrees by x-rays and visual aid to ensure that the degree of curvature doesn't not increase.**

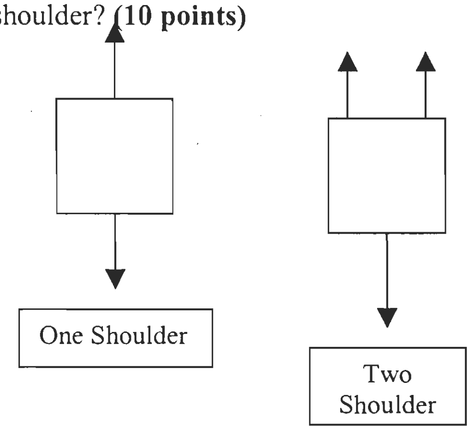
2.) **Milwaukee Brace- for curves of 25-30 degrees, a metal brace that is worn outside one's clothing for 22-23 hours per day. The brace cannot correct scoliosis, but rather keeps the curvature from growing. The brace is usually worn by adolescent patients who are still growing, and thus are at the greatest risk of the curvature increasing.**

3.) Surgery- a procedure called spinal fusion, in which the spine is straightened as much as possible by joining the vertebrae and preventing further curvature, is used for curves 40-50 degrees. Spinal fusion leaves the involved portion of the spine permanently stiff and inflexible, although functional activities are not strongly affected unless the lowest, lumbar region is fused.

5.) There is a debate between school officials concerning scoliosis. What is the cause of this disagreement, and where do you stand in this issue? Briefly support your position. **(10 points)**

The debate is centered around whether or not scoliosis screening should be allowed to continue in middle and high schools. Opponents of school screening argue that approximately 90% of students are told to see their physicians for problems with curvature of the spine, whereas only 1/10 of these students actually have scoliosis. Furthermore, only 1/1,000 students actually needs treatment in the form of brace or surgery for scoliosis. Supporters of school screening argue that scoliosis qualifies under the principles of effective screening programs set the nation. The principles state that the condition screened for must be an important health problem (with 1/10 students having scoliosis, which can lead to separation of the ribs if left untreated up to adulthood, scoliosis would surely qualify). Also, there must be a asymptomatic phase of the disease during which it is the only means to identify affected individuals (for the majority of students who have scoliosis during adolescence, they rarely experience symptoms for slight curves). Tests or examinations for scoliosis are both simple and reliable, as curves are visually detected by medical practitioners or nurses. There are also acceptable and feasible treatments for scoliosis available, one of which, the brace, may be only used if the scoliosis is detected early during adolescence.

6.) In terms of force diagrams, why is it better to wear your backpack on 2 shoulders rather than one shoulder? **(10 points)**



While wearing a backpack on one Shoulder as seen, the force attributed to the weight of the backpack is centralized on only one shoulder, thus straining the trapezius and deltoid muscles found there. On the two shoulder force diagram, we can see that the same weight of the backpack is distributed across two shoulders, thus easing the force on each individual shoulder. A waist-belt would be even better, since the weight of the backpack would be distributed across both shoulders and the substantially sturdier pelvis bones.

7.) Osteoporosis cannot be prevented:

TRUE **FALSE**

If you chose false, please explain why. **(5 points)**

A healthy diet throughout life with the recommended daily allowance for calcium (1000-1500 mg.) and Vitamin D (400-600 I.U.) is all that is needed to prevent this bone degrading disease. Good sources of calcium include low-fat dairy products, dark-green leafy vegetables, tofu, and any other calcium-fortified food.

8.) In Boston the sunlight from the end of October through the beginning of March is too weak for the skin to produce any Vitamin D.

TRUE FALSE

If you chose false, please explain why. **(5 points)**

9.) The two most essential vitamin/minerals for healthy bones are: **(5 points)**

a.) Vitamin C/Calcium
b.) Vitamin D/Calcium
c.) Biotin/Calcium
d.) Vitamin E/Calcium
e.) Vitamin E/Vitamin C

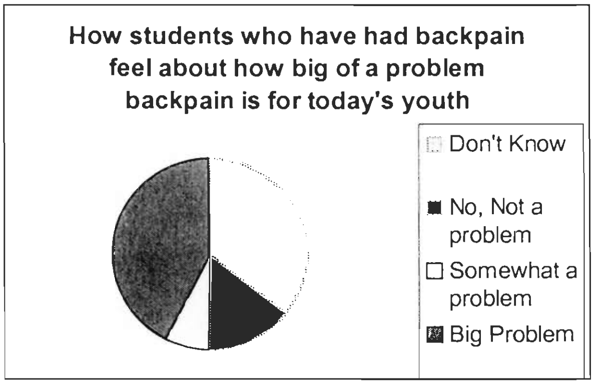
10.) List two of the five common exercises that physicians now recommend that you avoid and give a brief reason for why these exercises should be avoided. There will be bonus points if you can list more than two of the exercises. **(10 points)**

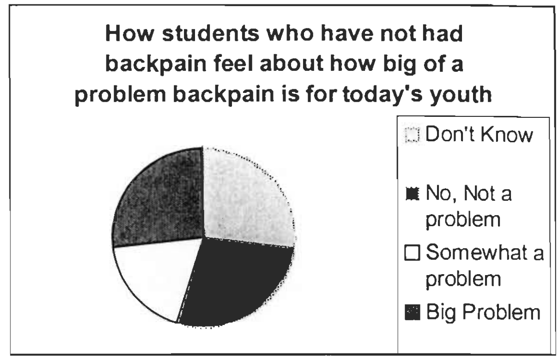
1.) **Avoid bending over to stretch the hamstrings (touching toes)- this exercise contracts the hamstring muscles and little flexibility is gained when a muscle is contracting. Also, forward flexion past 70 degrees stresses the lower back.**
2.) **Avoid double leg lifts- hip flexor and lower back muscles perform much of the work in a double leg lift.**
3.) **Avoid flexion and rotation exercises- put the back in the most vulnerable position.**
4.) **Avoid lifting the hands and feet at the same time as it increases disc pressure in the lower lumbar area of the spine.**
5.) **Avoid neck rolls- head circles compress the cervical discs and can potentially cause nerve damage.**

11.)Below you find some data that the class gathered in the backpack questionnaire. List which variable you feel is the dependent variable and which variable is the independent variable. Briefly explain how you chose which variable was which. Analyze the data in any way you feel is appropriate (percentages, bar graphs, pie graphs, charts, etc.). This is a very open-ended question and will be graded as such. **(20 points.)** **--variety of answers are acceptable for this question**

Have you experienced backpain?	**Do you think backpain is a problem for students your age?**
Yes	Don't Know
No	No, not a problem
No	Don't Know
Yes	Big problem
Yes	Don't Know
Yes	No, not a problem
No	Somewhat problem
Yes	Don't Know
Yes	Big problem
Yes	Big problem
No	No, not a problem
No	No, not a problem
Yes	Big problem
Yes	Don't Know
Yes	Big problem
Yes	Big problem
Yes	No, not a problem
Yes	Don't Know
Yes	Somewhat problem
No	Somewhat problem
No	Big problem
No	Don't Know
No	Big problem
No	Big problem

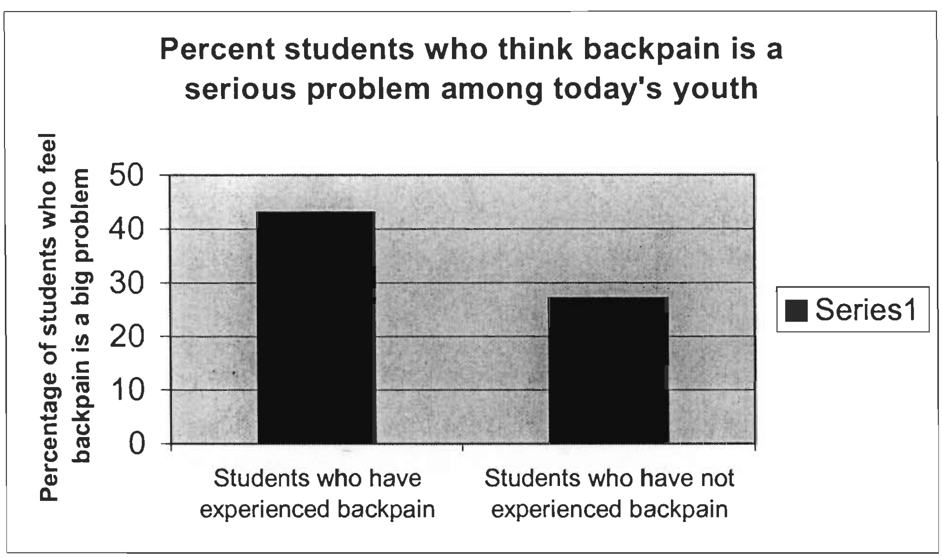
	Backpain a problem for students your age?			
Experienced Backpain?	Don't Know	No not a problem	Somewhat Problem	Big Problem
YES	5	2	1	6
NO	3	3	2	3





Of the students who experienced backpain:
35% said they don't know if backpain is a serious problem among today's youth
12% said they do not think that backpain is a serious problem among today's youth
7% said they do not think that backpain is a serious problem among today's youth
43% said they do not think that backpain is a serious problem among today's youth

Of the students who did not experience backpain:
27% said they don't know if backpain is a serious problem among today's youth
27% said they do not think that backpain is a serious problem among today's youth
18% said they do not think that backpain is a serious problem among today's youth
27% said they do not think that backpain is a serious problem among today's youth



Extra Credit:

What is a Dowargers Hump? It is a curvature in the spine caused by watching television while in the slumped position.

Appendix I
Post-Course Evaluation

North High School
Grade 9 Post-Course Survey

10.) What is your name? ____

11.) Rank you liking of the following subjects on a scale of 1 to 10, 1 being the lowest, and 10 being the highest:

k.) English (writing, spelling) __________
l.) Mathematics __________
m.) Life Science (biology) __________
n.) Physical Science (chemistry, physics) __________
o.) Health Sciences __________
p.) Social Studies __________
q.) Reading, Literature __________
r.) Computer Science __________
s.) Art/Drama/Dance __________
t.) Other (please specify) __________
____

12.) How much did you enjoy this health/science unit on backpacks and back pain?

not at all	not much	about average	quite a bit	very much
1	2	3	4	5

4.) How often did you learn about new things in this unit?

not at all	not much	about average	quite often	very often
1	2	3	4	5

5.) How much effort did you put into this unit compared to your usual health class?

not at all	not much	about average	quite a bit	very much
1	2	3	4	5

6.) Do you think you did well in this class?

no, not very well	below average	average	above average	yes, very well
1	2	3	4	5

7.) How important is the information you learned about science (forces, anatomy, physiology) and health (nutrition, exercise, scoliosis, back pain) in the Backpack and Back Pain unit to your daily life and the lives of your friends/family?

not at all important	not very important	somewhat important	important	very important
1	2	3	4	5

8.) How important will the information you learned in the Backpack and Back Pain Unit be to you future school work?

not at all important	not very important	somewhat important	important	very important
1	2	3	4	5

9.) If it were up to you, would you spend more or less time studying the topic of this unit?

Much less time	less time	about the same time	more time	much more time
1	2	3	4	5

10.) How interesting did you find the Backpack and Back Pain Unit?

not at all	not much	about average	quite a bit	very much
1	2	3	4	5

11.) How likely is it that you will go to college and study to become an engineer or a scientist?

not at all likely	not likely	likely	very likely	don't know
1	2	3	4	5

12.) Circle the choice that best describes your view of science.
Science is:

5.) interesting but not important
6.) important but not interesting
7.) important and interesting
8.) not important and not interesting

13.) Circle the choice that best describes your view of math.
Math is:

1.) interesting but not important
5.) important but not interesting
6.) important and interesting
7.) not important and not interesting

14.) Science helps me to learn how to think more clearly.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

14.) Math helps me to learn how to think more clearly.

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

15.) How would you compare the four weeks spent studying backpacks and back pain to other science subjects that you have studied this year?

Much better	slightly better	about the same	slightly worst	much worse
1	2	3	4	5

16.) Do you think that science is related to math?

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

17.) Do you think that science is related to health?

strongly agree	agree	disagree	strongly disagree	don't know
1	2	3	4	5

18.) If it were up to you, would you spend the whole year: (check one)

_______ learning different science units in the same way as the backpack and back pain unit was taught, or

_______ learning science the way it has always been taught.

19.) What is the most favorite lesson taught in the backpack and back pain unit? Why?

20.) What is your least favorite lesson taught in the backpack and back pain unit? Why?

21.) Do you have any questions or any comments that could help improve the quality of the curriculum taught?

Appendix J

Database Collection Proposal

Alka Basil
Alison Bailey
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To Whom it May Concern:

The purpose of our project is to design an S-STS (Science through Science, Technology, and Societal Issues) curriculum to combine the subjects of math, science, and health. The concept of S-STS was first developed by um Roy and Leonard Waks of Pennsylvania State University in the late 1970's and early 1980's and its approach uses a central theme around which the entire curriculum is resolved.

The focal point of our purposed S-STS curriculum is the growing health concern among pediatricians, school officials, and parents alike about the increasing rates of backaches and back pain in students caused by or exacerbated by heavy backpacks. A dramatic increase in the number of children complaining of back problems to their pediatricians and chiropractors alike has led to scrutiny of the weight that students carry both to and from school. Studies indicate that many students are carrying 20-30% of their body weight, which is much more than the recommended 15% set by medical practitioners.

The curriculum we propose would use the aforementioned health problem (which is most prevalent in students between 6th-8th grade who have not yet gained their full height) as a backdrop against which subjects such as physics, anatomy, physiology, statistics, graphing, and data analysis will be taught. Since middle school students are the most at risk for the effects of heavy backpacks, we propose to obtain a data set from these children which would include height, weight, and backpack weight. This data set would be used as part of the data analysis and graphing lesson for older students. A short, tow to three-day lesson plan for the middle school children could be created to explain the health concern and the purpose of collecting the data set. The actual S-STS curriculum would most probably be more suited for honors 10^{th} graders due to the content of the lesson plans along with the fact that the proposed curriculum contains material which the Massachusetts Guidelines for Science and Technology dictate is for tenth graders.

Muscles of the back (their origin, insertion, and function) that are injured due to increased force exerted by the backpack's weight will be studied along with the five regions of the vertebral column and their respective properties. Scoliosis will also be discussed, as heavy backpacks may increase the symptoms of scoliosis or may actually play a part in contributing to cause idiopathic scoliosis.

Mathematical concepts such percentages, ratios, graphing, the distinction between dependent and independent variables will all be taught so that students will have the tools available to analyze the results of the data set collected from the middle school children. An extensive lesson on experimental design that includes sampling techniques will also be taught so students can analyze the method used to collect the data from the middle school children. All lessons are designed such that traditional lectures are kept to a minimum and group activities, debates, projects, and discussions are emphasized.

The proposed S-STS curriculum has been field tested in its modifcied form at North High School in Worcester, MA on a ninth grade health class under the guidance of Mrs. Jackie Letino. Mrs. Letino along with the science and mathematics faculty at North High School all concluded that the curriculum showed much promise but had not found its optimum audience as of yet. They proposed that the curriculum should be moved from a health to a science classroom and should be considered interdisciplinary with links to mathematics due to the physics and statistics lessons. The curriculum presented to Noрht High School was modified in regards to its mathematics content due to the request of Mrs. Letino and the data set of backpack weight vs. student's weight was done by fairly weak sampling techniques. The data set was collected from the North Community and all sampling was done by the students, which rendered the data rather biased and tended to stray away from the sampling 6th-8th graders. Consequently, the results from the analysis were grossly unrepresentative of the health problem that was under discussion.

Since the S-STS curriculum is part of our school project from Worcester Polytechnic Institute, the last term of the project will be A term of 2000 (ending mid-October). During this time, we need to write a report, do a second full scale revision of the general curriculum unit for 10th grade, and create a 2-3 day mini-unit of consciousness raising for 6th-8th graders in which they would do some measurement of packs, so data is generated each year (hopefully). Ideally, we would like to create a database that is a true sample, drawn from about four different schools that differ in socioeconomic mix. We hope to bring diversity, representativeness, and a social class variable to the data set. This database can be updated yearly as the 2-3 day consciousness-raising curriculum is taught for the younger students at risk. Thus, the older kids can plot trends and deviations in the data year by year. With luck and your cooperation, we will be able to begin generating the database early next school year and add it to the statistics section before we wrap p in late October.

As mentioned, we will be unable to continue work on the project after October 20th, and we will actively seek to recruit another team from Worcester Polytechnic

Institute to refine and field test the unit with a full scale statistics and graphical display of numeric data. Our goal until October would be to begin generating our database for the curriculum as well as reform our current curriculum.

Thank you very much.

Sincerely,

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Appendix K
Mini S-STS Curriculum
Worcester East Middle School

Question: Why was the weight of my backpack taken?

Answer: Pediatricians, health educators, and students alike have all noticed an increase the weight of backpacks carried by students during the past several years. Students are carrying as much as thirty to forty percent of their body weight on their backs, numbers which are causing students to have serious problems such as acute back pain and posture problems. Chiropractors and health care professionals state that the number of students visiting them due to the aforementioned problems is at an all time high. Health officials state that the students most affected by the heavy weight of backpacks are in the late elementary to early middle school years, since they have the ratio between their body weight and backpack weight is the greatest since they are still growing.

The reason for this recent upsurge in the weight of backpacks can be attributed to many factors. The average weight of textbooks that students are given is increasing, as textbook publishers have started to condense different subjects worth of work into one textbook. Also, students tend to be carrying more weight in their backpacks due to sports equipment and other such after-school activities. The recommended weight to be carried by students is between 15-20% of their body weight.

We had already taken a sample from North High School which included backpack's weight, student's weight, and student's height. However, the manner in which this survey was conducted led us to believe we could have a possible sampling bias. The survey was conducted by handing out seven questionnaires (the same ones you filled out) to each 9th and 10th grade student in a health class (there were 13 students in the class). The health class was to ask younger siblings, or if they didn't have any friends, to fill out the questionnaires so they could be analyzed.

The reason we are doing this survey again at Worcester East Middle School is to determine whether the North High School data was representative as a sample population. To do this, we need to see if the North High School data follows the same trend that the Worcester East Middle School data follows in terms of normal distributions and the mean, median, mode of the data.

WHAT ARE SOME PROBLEMS WITH THIS SAMPLING METHOD?
ANSWERS:

- The sampling age we were hoping to get was mostly 6th-8th grade. However, we mostly got high school students in the sample since many of the students just asked their friends.
- The sample was not a random sample in that it did not even represent all of North High School. Rather, it represented the friends of the health class, which essentially excluded all 11th and 12th graders. This is called a selection bias.
- Many of the questionnaires that were returned were incomplete and only about fifteen students filled in their height, weight, and weight of backpack. This was due to not having access to a scale when the survey was done, and

the fact that many students didn't want to put down their weights for their friends to see. This is called a nonresponse bias.

- The fifteen weight and height measurements we received were weighed on different scales, thus introducing equipment error.

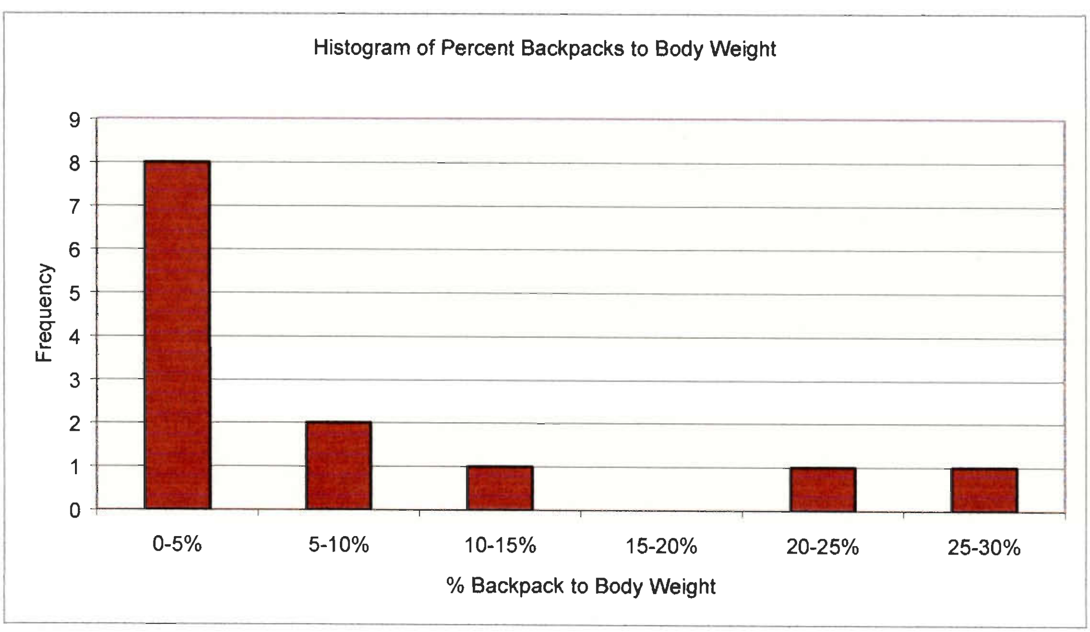
HOW WERE THESE PROBLEMS OVERCOME AT WORCESTER EAST MIDDLE?

ANSWERS:

- The sample was random this time, with students from all grades we are interested in present. This improved our sampling error bias.
- The height, weight, and backpack weight were taken anonymously and apart from other students, so the nonresponse bias was cut down significantly.
- The heights and weights were all done on the same scale, reducing error due to the equipment.

NORTH HIGH DATA

Weight of student	Weight of Student and Backpack	Weight of Backpack	Percent Backpack to Body Weight	Height
75	78	3	4	5'1
97	100	3	3.092783505	5'7
97	100	3	3.092783505	5'7
98	102	4	4.081632653	5'2
195	200	5	2.564102564	5'7
180	180	0	0	5'5
96	96	0	0	
200	200	0	0	5'6
120	150	30	25	5'4
120	130	10	8.333333333	5'7
102	132	30	29.41176471	5'6
140	160	20	14.28571429	
80	87	7	8.75	4'8



The above graph shows that the data does not follow a normal distribution. Normal distributions are bell-shaped (see above), which are based on the mean and standard deviation (measure of how close the data points are). Rather the data above follows a left skew and follows a logarithmic or exponential pattern.

There are three types of "averages" used to analyze this data in statistics.
Mean = 7.893 % backpack to body weight (is defined as the mathematical average)
Median = 4 % backpack to body weight (found by arranging the data points from in order from least to highest and taking the middle data point. If there are an even number of data points, the average of the middle two points is taken)
Mode = 0 % backpack to body weight (most frequently occurring data point)

WHY ARE THERE THREE DIFFERENT VALULES FOR THE "AVERAGE"?
The mean of the data points is higher than the other two values of the "average". The reason for this is that the two higher values of percent backpack to body weight, 25 and 29 percent, are significantly affected this calculation. Therefore, it can by hypothesized that these two values are outliers (data points that are significantly apart from the rest of the data points). In this case, the median would be a better representative of the data from North High School. Therefore, it can be concluded that the excess weight of backpacks in not a problem for the friends of the health class at North High School.

SO, DOES NORTH HIGH SCHOOL FOLLOW THE PATTERN FOUND AT WORCESTER EAST MIDDLE?

Appendix L
Mini-Traditional Curriculum
Worcester East Middle School

Introduction

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The reason for this recent upsurge in the weight of backpacks can be attributed to many factors. The average weight of textbooks that students are given is increasing, as textbook publishers have started to condense different subjects worth of work into one textbook. Also, students tend to be carrying more weight in their backpacks due to sports equipment and other such after-school activities. The recommended weight to be carried by students is between 15-20% of their body weight.

Lesson One: Statistical Measures

A. Mean- sum of the observations divided by the number of observations (known as the average)
B. Median- "half-way" point of the ordered distribution. If ordered distribution is even, then the average of the two middle points is taken.
C. Mode- most frequently occurring data point or points
D. Standard Deviation- tells you how spread out numbers are from the mean. Calculated by taking the square root of the arithmetic average of the squares of the deviations from the mean in a frequency distribution
E. Graphing Data Points
    a.) x- independent variable
    b.) y –dependent variable (depends on x)
        Example: The amount of snow you get depends on the month.
        Month= x axis and Amount of snow = y axis
    c.) When plotting a graph, the x –axis is on the horizontal line and the y-axis is on the vertical line.
F. Types of graphs
    a.) Bar Graph (also called Histogram)- A histogram is defined as a bar graph that shows frequency data. The first step in making a histogram is to collect data and sort it into categories. To continue, you must label the data as the independent set or the dependent set. The characteristic you grouped the data by would be the independent variable and the frequency of that set would be the dependent variable.
G. Normal Distribution- Bell Curve
    a.) Continuous distributions such as the normal distribution occur as the number of trials in an experiment increases toward infinity. That is to say, if you take several measurements over

and over again, for years, the histogram you get will start to look more and more like a smooth curve

H. Percentages:

a.) To convert a fraction to a decimal just divide the top number by the bottom number. The top number is called the numerator and the bottom number is called the denominator. Then, multiply this number by 100

b.) Percentages can be thought of as a ratio of part to whole where the "whole" is 100%. So, for example, if there are 25 girls in a classroom of 100 students, then 25% of the class is girls.

c.) A percent is a ratio whose second term is 100. Percent means parts per hundred. The word percent comes from the Latin phrase *per centum,* which means per hundred. In mathematics, we use the symbol % for percent.

Assignment for Mean/Median/Mode Lesson:

There are three different basketball teams and each has played five games. You have each team's score from each of its games.

	Game 1	Game 2	Game 3	Game 4	Game 5
Jaguars	67	87	54	99	78
Wolves	85	90	44	80	46
Lions	32	101	65	88	55

1. Suppose you want to join one of the three basketball teams. You want to join the one that is doing the best so far. If you rank each team by their mean scores, which team would you join?

2. Instead of using mean scores, you use the median score of each team to make your decision. Which team do you join?

3. Pretend you are the coach of the Lions and you were being interviewed about your team for the local newspaper. Would it be better for you to report your mean score or your median score?

Situation B

You and your friends are comparing the number of times you have been to the movies in the past year. The following table illustrates how many times each person went to the movie theatre in each month.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
John	1	3	2	5	2	3	1	4	2	3	2	1
Mary	1	2	1	1	1	3	3	2	2	4	1	2
Brian	1	3	2	2	1	4	5	3	2	2	1	3
Kelly	2	2	1	1	3	2	4	1	3	2	3	2

1. By comparing modes, which person went to the movies the least per month?

2. By comparing medians, which person went to the movies the most per month?

3. Rank the friends in order of most movies seen to least movies seen by comparing their means.

4. Which month, by comparing the means of movies seen in each month, is the most popular movie-watching month?

5. By comparing medians, which month is the least popular month?

6. What is the mean of the medians for each month (the arithmetic average of the medians of the number of movies seen in each month)?

Answers

Situation A:

Answer 1: Jaguars (The mean score is 77)

Answer 2: Wolves (The median score is 80)

Answer 3: The mean score (The mean score is 68.2 and the median score is 65)

Situation B:

Answer 1: Mary (Her mode is 1)

Answer 2: They all went the same amount (The medians are all 2)

Answer 3: 1. John and Brian (Their mean is 2.4167), 2. Kelly (Her mean is 2.167), 3. Mary (Her mean is 1.9167)

Answer 4: July (The mean for July is 3.25)

Answer 5: January (The median for January is 1)

Answer 6: 2.0833

- Taken from: http://www.shodor.org/interactivate/lessons/st4.html

Assignment for Percentages Lesson

Example 1: Write each ratio as a fraction, a decimal, and a percent: 4 to 100, 63 to 100, 17 to 100

Solution			
Ratio	**Fraction**	**Decimal**	**Percent**
4 to 100	$\frac{4}{100}$	.04	4%
63 to 100	$\frac{63}{100}$	.63	63%
17 to 100	$\frac{17}{100}$	.17	17%

Example 2: Write each percent as a ratio, a fraction in lowest terms, and a decimal: 24%, 5%, 12.5%

Solution			
Percent	**Ratio**	**Fraction**	**Decimal**
24%	24 to 100	$\frac{24}{100} = \frac{6}{25}$	.24
5%	5 to 100	$\frac{5}{100} = \frac{1}{20}$	.05
12.5%	12.5 to 100	$\frac{12.5}{100} = \frac{125}{1000} = \frac{1}{8}$	.125

Example 3: Write each percent as a decimal: 91.2%, 4.9%, 86.75%

Solution	
Percent	**Decimal**
91.2%	.912
4.9%	.049
86.75%	.8675

Assignment for Graphing

Does the data below follow a normal distribution?

Do you see any trends in the data? If so, explain.

Data – Density of a Liquid	
1.40	1.49
1.70	1.49
1.41	1.50
1.60	1.48
1.42	1.47
1.58	1.48
1.59	1.48
1.59	1.58
1.44	1.46
1.45	1.49

Appendix M
Permission Slip
Worcester East Middle School

Dear Parent(s):

Our names are Alka Basil and Alison Bailey and we are students at Worcester Polytechnic Institute. As part of coursework, we are conducting a study at Worcester East Middle School with the permission of Principal Kevin Keaney regarding the increasing weight of backpacks carried by students in the middle school grade level.

During the past decade, medical professionals have reported an increase in the number of student complaints regarding back, neck, and shoulder pain linked to backpacks overloaded with books. The U.S. Consumer Product Safety Commission reported that about 240 children were treated in hospital emergency rooms in 1997 for back strain or sprains after carrying backpacks. Recent medical studies have shown that students are carrying up to 30% of their body weight on their backs, with most of the load distributed on one shoulder. Consequently, an increasing number of children are complaining of back pain and suffer from poor posture as reported by pediatricians and chiropractors alike.

In light of this problem, we are conducting a study to see if this increase in backpack weight nationwide is also profiled at Worcester East Middle School. In order to do this, your child will be asked to fill out a twenty minute survey regarding how long they carry their backpack, how they carry their backpack (one shoulder or two), whether they feel the weight of their backpack is too heavy for them to carry comfortably, and whether they have ever experienced back pain as a result of their backpack. In addition to filling out the survey, the weight and height of your child will be taken along with the weight of his/her backpack. All the information will be completely anonymous, and all weight and height measures will be taken in the privacy of the nurse's office.

To educationally enhance this experience for your child, your child's math teacher will also present a short two-three day mathematical curriculum so that classes may analyze the data obtained. Topics to be covered in the lesson will include statistical concepts such as mean, median, and mode, the idea of a bell-curve, graphing, and percentages.

If you do not wish for your child to participate in the aforementioned study, please sign and return this permission slip as soon as possible so that your child may be excused during data collected day on November 6, 2000.

Thank you very much for your cooperation. If you have any further questions or concerns regarding the survey, please do not hesitate to contact the school.

Student's Name:________________________________

Parent's Signature:________________________________