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The Need for Education Reform

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Abstract

Extensive research was done on education reform according to the Massachusetts Department of Education, Dr. Theodore Sizer, and the National Council of Teachers of Mathematics. For eight weeks an innovative mathematics program was taught at Wachusett High School. During this time professionals in the field were questioned about their views on education reform in an attempt to form personal views on the changing system of education.

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Introduction

For several years I have entertained the idea of becoming a teacher, because it would combine my passion for mathematics and learning with my strong desire to work with young people. I am currently working towards a Bachelors of Science in Mathematics, and I would like to take my knowledge of the subject into the classroom and help high school students to develop a love for the subject. As a prospective WPI student I heard about the WPI plan, but never fully understood the impact it could have on my future. In the spring of 1998 I successfully completed my sufficiency project and began to investigate potential projects to fulfill my IQP requirement. That is when I discovered the "perfect" project for me. I would be given the opportunity to teach high school mathematics.

For eight weeks I prepared. This preparation included researching the changing times in education as well as observing various teaching methods and styles. Through this research I discovered why education reform is necessary. I am a product of the educational standards of the past; from my observations I discovered the educational processes of the present and most importantly I saw the reason why education needs to change for the future. I also learned that changing a system that has been in place for years is nearly an impossible task, but a very necessary challenge.

I taught at Wachusett High School in Holden, Massachusetts. During my first meeting with the head of the mathematics and science department we discussed teaching options. I was given several alternatives. I could teach a traditional geometry class or a new mathematics program the school implemented last year. The second option intrigued me. I had done extensive research on

education reform and I was convinced that mathematics curriculums were moving away from the traditional approach. It was a rather difficult decision to make. I decided I wanted to teach the new and innovative math class known as IMP.

It was decided that I would teach two grade levels; a class of freshman and a class of sophomores. I did not realize that an additional year of schooling had such a large impact on maturity levels. It seemed like I was teaching in two different worlds; the freshmen were very social whereas the sophomores came to class ready to work. I soon realized that when teaching two different classes two different teaching approaches are necessary.

My eight weeks at Wachusett High School gave me the experience and knowledge one could never attain from a textbook. The faculty and staff created a hospitable atmosphere; I felt comfortable asking questions about teaching styles and methods. While reading books and newspaper articles about reform gives insight into new ideas, discussing issues with professionals is the best way to understand the impact reform will have.

I. Education Reform Act of 1993

On June 18, 1993 the Massachusetts Education Reform Act was signed into law. Section twenty-seven of the law makes a profound statement about Massachusetts goals and responsibilities of education. This section states, "It is hereby declared to be a paramount goal of the commonwealth to provide a public education system of sufficient quality to extend to all children the opportunity to reach their full potential and to lead lives as participants in the political and social life of the commonwealth and as contributors to its economy". Although the system of education currently in place achieves some of these goals, the legislature and citizens of Massachusetts realized the system was in need of a change. The section continues to state four things to ensure that all students will reach their full potential: each student will learn in a classroom environment in which learning is enjoyable and has no threats to security or self-esteem. It also states that students shall receive resources to provide a high quality education. There will also be a process for establishing specific educational goals for every child, and there will be a monitoring process of these goals, which holds educators responsible.

These goals were very noble and the state of Massachusetts had the best intentions in mind when signing them into law. That was the easy part, implementing the goals would be the hard part. The system of education they wanted to make radical changes to has been in place for many years. People went to school, the teacher taught them important information, they went home did their homework, returned to school and they were tested on the material. People did this for twelve years of formal education, and after twelve years they knew many things, but what had they

learned and were they ever forced to think? Many people believed that graduating high school seniors today are not critical thinkers. Is this the fault of lazy students, or are they given a poor education by a failing system? If it is not the students, but the way they were taught, how can we change it? The state of Massachusetts has it ideas on how to change the system, as does everyone else.

If you want to change the way people are taught you need people to teach who are going to be able to deliver the material in a new way. This means attracting young and talented teachers into the profession. The state has several ideas about how to do this, one of which is stated in section twenty-two of the Education Reform Act. "There shall be a student loan repayment program known as attracting excellence to teaching program, for the purpose of encouraging outstanding students to teach in public schools of the commonwealth by providing financial assistance for the repayment of qualified education loans". These "qualified education loans" are defined as any indebtedness including interest to pay tuition or other direct expenses incurred during the pursuit of an undergraduate or graduate degree. The loan repayment program has several requirements that must be met by the applicant. The applicant must have graduated in the top quarter of their class, and the commonwealth will repay the loans at a rate no more than one hundred and fifty dollars per month for no more than forty-eight months. This program was established to attract talented teachers with degrees in the subject they will teach.

The state of Massachusetts also realizes the importance of technology. In the changing times and as the new millennium approaches the use of computers and technology is becoming more

and more commonplace. The state places a technology plan into action. This plan is stated in section seventeen of the Reform Act. "A statewide educational plan, to be known as Massachusetts education-on-line, shall be developed by the Massachusetts corporation for educational telecommunication". The plan has several goals, which are to integrate technology into teaching and learning. This includes a "technology link among public colleges and universities and school districts through the use of computer technology". It also includes "the facilitation of the implementation of a statewide profession development plan for teachers, principals, and superintendents using distance learning". The commonwealth also includes "increased involvement of parents, guardians, mentors, or other volunteers with their students education by utilization of distance learning". This section of the law continues to state, "the educational technology plan shall be broadly construed to programs, courses, and capital expenditures including computer hardware and software, networks, televisions, satellite transmissions, fiber optics, cable, calculators and video and audio tapes". The commonwealth recognizes the uses of technology in everyday life and sets a plan into motion in which all students will know how to use such technology.

Now that the state has attracted these new and talented teachers and education-on-line is in action, how is the state going to ensure these changes are working? Section forty of the law has an answer for that question. It states, "The superintendent shall require the evaluation of administrators and of teachers without profession status every year and shall require the evaluation of teachers with professional status at least once every two years". Professional status is a certified

teacher in Massachusetts, a full certification requires that the professional have a master's degree in education. These evaluations ensure that teachers are effective and using the new technology to spark their students' interest.

The state also realizes that some students and parents are looking for other schooling options. The establishment of charter schools is discussed in section eighty-nine of the law. "A charter school shall be a public school, operated under a charter granted by the secretary of education, which operates independently of any school committee and is managed by a board of trustees". The purposes for establishing a charter school are: "to stimulate the development of innovative programs within public education, to provide opportunities for innovative learning and assessments, to provide parents and students with greater school options, to provide teachers a vehicle for establishing schools with alternative, innovative methods of educational instruction, to encourage performance-based educational programs, and to hold teachers and school administrators accountable for students' educational outcomes". The state includes in the law that only twenty or fewer charter schools can be operating in the commonwealth at any time. It limits five charter schools to the cities of Boston and Springfield, and no more than two in any other city or town. "Charter schools may limit enrollment to specific grade levels or areas of focus of the school, such as mathematics, science, or the arts". There is no tuition charge for attending these charter schools. The students attending the charter schools are required to meet the performance standards, and testing requirements set by the board of education for students in other public schools. The state of Massachusetts grants a charter for

five years. A charter can be revoked, and the secretary of education will set up guidelines for the renewal of charters.

II. The Coalition of Essential Schools

The idea of charter schools steamed from a reform movement started by Ted Sizer. Dr. Sizer has had a long career in education, including teaching at Boston Latin, and in Australia. He was an assistant professor at Harvard, then their dean of the Graduate School of Education. He was also chairman of Brown University's Education Department, and the chairman of the Coalition of Essential Schools at Brown University. The Coalition of Essential Schools (CES) was founded in 1984. The idea for the coalition began after Dr. Sizer's documented research. From this five-year research project he wrote a book about the problems in American high schools entitled "Horace's Compromise: The Dilemma of the American High School". The Coalition of Essential Schools is based on a philosophy of Nine Common Principles. All schools in the CES agree to follow the following guidelines. These guidelines can be found in the pamphlet of the Coalition of Essential Schools.

1. Students should learn to use their minds well.
2. "Less is More" The goals of schools should be simple and clear, and the essential skills to be mastered by the students should be limited and focused.
3. The goals of the school should apply to all students; the way in which those goals are to be accomplished should be tailored to the individual student.
4. To personalize education, the staff of the school should make decisions only, and teachers should not be responsible for more than 80 students.

5. Teachers should be seen as coaches, rather than delivers of facts. Students should be expected to teach themselves actively.
6. Standards for proceeding to higher levels of schooling should be established. Graduation should be based on exhibitions-the students' demonstration of their mastery of the school's essential skills.
7. Schools should have values of expectation, trust, and decency. Parents should be active in the schools' planning and running.
8. Principals and teachers should be primarily generalists as opposed to specialists. They should have several different responsibilities, so that their commitment to their schools is complete.
9. To provide staff with competitive wages and ample planning time, funds should provided by reducing peripheral school services.

Once a school joins the coalition it makes a four-year commitment to the program. It assesses itself once every two years, school staff and coalition colleagues make this assessment. As of 1995 approximately 800 schools in the United States were a part of the coalition. The nine principles place most emphasis on the "student as a worker" and "teacher as coach," "less is more", and that exhibitions show a students' mastery of a subject. Dr. Sizer states "We start form the assumption that good schools are unique. In order to be good, a school has to reflect is own community. And therefore, we offer no model. There's nothing you can just "put into place," nothing to "implement." Our research suggests you're not going to get significant, long-term reform unless you have a subtle but

powerful support and collaboration among teachers, students, and the families of the students in a particular community" (O'Neil, 1995).

Since the Education Reform Act of 1993 charter schools have become a popular schooling option in Massachusetts. The first charter school opened in August of 1995. As of 1997 fourteen schools have been in operation for two years and eight schools have been operating for one year. Two new schools opened that fall and another was scheduled to open before the end of 1997. As of September of 1997 enrollment in charter school doubled, from 2,565 in the school year of 1995-96 to 6,669. The Education Reform Act stated that charter schools would have more flexibility to design and operate schools, while having an increased accountability for their students' achievement.

There was some hesitation about the implementation of charter schools. Community members worried the schools would be primarily made up of white students, as well as a concern the schools would exclude language-minority students. There was also concern charter schools would attract only the brightest students with the most involved parents. The Pioneer Institute for Public Policy Research profiled Massachusetts charter schools for the 1996-97 academic year. The following results are from that research.

Forty-seven percent of charter school students are minorities; thirty-nine percent of charter school students are economically disadvantaged. For thirteen percent of charter school students their first language is not English. These percentages are all higher than the Massachusetts statewide averages. Only twenty-five percent of charter school parents said they had an above average involvement in their child's

previous school. Forty percent of parents stated that their child's academic performance was above average at their previous school. Sixty percent of charter schools are located in urban areas.

The Institute also surveyed students and parents about their experiences at charter schools. Eighty-six percent of students said their school experience was "excellent" or "good." Eight-one percent of parents said the charter school experience was better than that of their child's previous school. Ninety-four percent of parents plan on sending their other children to charter schools. Parents are involved in the school governance at a rate of seventy-two percent, and forty-seven percent of parents volunteer at the school. When the students were asked how interested they were in their schoolwork ninety percent of them answered either "interested", or "extremely interested." Ninety-four percent of parents rate the schools' ability to motivate students as "excellent" or "good." Seventy-seven percent of parents say the curriculum and teaching methods are better at the charter schools than the previous attended school. Ninety percent of students rate their teachers as "excellent" or "good."

III. The National Council of Teacher's of Mathematics

The National Council of Teacher's of Mathematics (NCTM) documented a set of guidelines for reform in mathematics. This was done with two tasks in mind: They want students to become mathematically literate in a world that relies on calculators and computers and in a world where mathematics is rapidly growing in diverse fields. The council also wanted to create a set of standards that revise the current curriculum. Historically high school mathematics was provided to students with the purpose of helping them to attain mathematical knowledge, skills, and thought processes for daily life. Unfortunately this was done in a lecture-based classroom, where students were expected to learn facts and then regurgitate them on command. This system of "learning" has been in place for many years, and the NCTM has ideas on how to improve the failing system.

The NCTM believes that high school mathematics must encourage students to value math, gain confidence in their abilities, become problem solvers, and have the ability to reason mathematically. The purpose of the reform movement is to prepare students to live in the twenty-first century. The NCTM standards should be seen as a way to prepare the students to do this. In order to make changes in curriculum new goals must be established. All countries have changed from industrial societies to technological societies. This change has brought about a necessary change in mathematics in order to produce people who can thrive in the new age of technology.

According to the NCTM the new goals for education should include:

1. mathematically literate workers
2. lifelong learning

3. opportunity for all

4. informed voters

Mathematically literate workers are necessary because new production methods demand a technologically competent work force. People must be able to understand the complex systems of communication, they must ask questions, and they must have the ability to work in groups. People with a strong mathematics background will be able to accomplish all these things. In order to have a competent and flexible work force people must be life long learners. With technology changing rapidly people must be able to adapt to new systems quickly, becoming good problem solvers is extremely important. Preparing students for this should be a paramount goal of schools. Another goal is that the past social injustices of schooling will not be tolerated. Statistics show that those most mathematically competent are white males. Women and minorities study mathematics less because they are not encouraged to do so. In order to have an economically productive society people must be considered equals. The United States is a democratic society in which every person has a voice in governmental decision making. Citizens must be able to read and interpret complex information in order to make informed decisions about current and pressing issues. All of these goals can be introduced in a high school math class and if presented effectively these four goals will be achieved throughout a student's lifetime.

The NCTM also states goals for all students K-12. These goals are:

1. students learn to value mathematics

2. they become confident in their ability to do math

3. they become mathematical problem solvers
4. they learn to communicate mathematically
5. they learn to reason mathematically

Students must be exposed to different types of problems and experiences so that they can understand how mathematics is involved in human affairs. Students should also be encouraged to explore, guess, and make correct and incorrect errors in order to gain confidence in their ability to solve problems. Students should have the abilities to read, write and discuss mathematics. The NCTM believes if they are exposed to the standards the will gain "mathematical power." Mathematical power is defined as "an individual's abilities to explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems".

The NCTM has based their standards on three premises. In order to know math, you must do math. The curriculum for all students must provide opportunities for students to develop an understanding of mathematical models and structures that apply to many disciplines. With the advancement of technology math classes must include things which were not important ten years ago. Calculators must be available to students at all times. There should be a computer in the classroom to use for demonstrations; every student should have access to a computer. Students should use computers as a tool for processing information. Calculator and computer use in mathematics should become as common place as word processors for writing. Even though students will use calculators more they need to know how to compute things on their own. Students can not become calculator dependent.

Teaching methods currently rely on a lecture-based classroom and students are expected to practice and manipulate expressions and algorithms. Knowledge should come from problem solving experience. Students need to recognize the tools necessary to solve a problem and at the same time have the mathematical ability to solve it. Students should thrive on the search for answers. These answers can be found through group work. When students join the work force most of their work will be done in a group. It is vital to learn group dynamics at an early age.

These changes in technology and in the changing needs of students require the need to change teaching methods. A variety of methods should be used in the classroom in order to stimulate students' interests. The tradition teacher-led discussions are not an effective teaching method. The classroom should be an environment of open discussion; students should be encouraged to ask questions and share ideas. They should work in-groups on a regular basis; they should be encouraged to learn things on their own and peers should be encouraged to help one another. The teachers should be perceived as coaches of their students, rather than delivers of information. Teachers and students should be partners in the learning process. When students learn on their own and from each other it strengthens their mathematical ability as well as their self-esteem. They gain a confidence in themselves and in their mathematical skills. Students should be encouraged to be self-directed learners. Self-directed learning paves the way for life long learning to occur.

The NCTM believes their core curriculum has several advantages over a traditional curriculum. They believe their curriculum provides "equal access and opportunity to all students". The proposed changes give all students the

opportunity to fulfill their mathematical potential. The curriculum gives non-college attending students the skills needed to thrive in a technological society. The curriculum gives students interesting problems to solve, which stimulates their interest in mathematics. The idea behind the curriculum is that students will be given a new approach to learning mathematics, this approach builds on what students know instead of showing students how much they don't know. In order for the curriculum to be effective the teachers must challenge their students. The main goal of the NCTM curriculum is that all students have the opportunity to learn.

IV. The Interactive Mathematics Program

A mathematics curriculum based upon the NCTM standards has begun to be implemented in American high schools. The Interactive Mathematics Program (IMP) began in 1989 with a grant from the California Postsecondary Education Commission. The goal of the program is to redesign the tradition high school math sequence to a three-year curriculum that focuses on problem solving, mathematical reasoning and communication. The curriculum includes topics from the traditional high school mathematics curriculum, as well as topics from statistics, probability, and discrete mathematics.

The IMP curriculum is different from the traditional mathematics classroom because it is problem-centered, integrated, it expands the scope of high school mathematics, and it includes long-term, open-ended investigations. Students in the IMP program can see ways in which mathematics is used outside the classroom. The students' work is done in problem solving situations where topics form several areas of mathematics are used to answer real world questions. The students' study of statistics, probability, and discrete mathematics reflects the need for these skills in today's society. The curriculum helps students to develop an in-depth understanding of mathematical concepts and ways to apply them.

This new curriculum forces the students to think and learn in a new way, teachers must implement new teaching methods in order to be effective instructors. The teachers' role in the IMP classroom is very different from the role of the traditional teacher. This new role requires teachers to be observers and listeners. They must ask students questions in order to provoke students to do their own thinking. Students can no longer be

hand fed information; they must be able to solve problems on their own. Teachers must have high standards and goals for all students, not just the students with superior mathematical skills. All students have the ability to succeed in mathematics, and the IMP program allows all students to have a high level of achievement.

In the IMP classroom students take a more active role in learning. The students go beyond mathematical computations; they take these numerical answers and apply them to problems to make assumptions about real world situations. These real world situations show students how mathematics is used outside the classroom. Once students see that material learned in school has an affect on their daily lives they strive to find answers to questions and their determination to find these answers dramatically increases.

The IMP classroom also has an aspect of written and oral communication. On a regular basis students give oral presentations to the entire class. These presentations force students to explain their ideas, methods, and conclusions. Questions asked by peers as well as the teacher gives students' confidence; they learn to fully explain why they did something. Students are frequently asked to justify answers, these justifications are detailed explications of methods and conclusions. If students can demonstrate why and how they did something, either orally or in written form, the teacher knows real learning has taken place, written and oral communications deepen students understanding of material.

Another important aspect of the IMP classroom is group work. When students enter the work force most of their assignments will be completed in groups. The younger students are when they begin

to understand the dynamics of a group the more they are to thrive in the working world. As students learn to work in groups the more confidant they become in their work and in themselves. Working with a team of people also makes students feel more responsible for their work.

The IMP program also differs from the traditional classroom in the methods of evaluation. In the IMP classroom there are no timed tests, no multiple choice, or short answer questions. These are not true evaluations of what a student has really learned. The grades in an IMP classroom are based upon homework, oral presentations, problems of the week, group discussions, and an assessment at the end of each unit. When students have true understanding of material they can answer questions related to the material either written or orally.

According to the NCTM standards all students should have graphing calculators available to them at all times. The designers of the IMP program also recognize the importance of the graphing calculator. The graphing calculator is an important tool in a mathematics classroom; students will spend more time focusing on ideas and less time on tedious calculations. Students can experiment with the calculators, formulate conjectures and test them quickly. Students will focus on ideas and concepts instead of getting stuck on computations.

V. Wachusett High School

I have had personal experience with the IMP program. For four weeks I taught an IMP year one as well as an IMP year two class at Wachusett Regional High School in Holden, Massachusetts. During the time I was involved in the program I realized that significant changes were beginning to take place in education. I saw first hand that the IMP mathematics class is extremely different from the traditional mathematics sequence. While I was teaching at Wachusett High School I learned about the IMP program and how it is an effective alternative to a traditional mathematics class, and I learned about the art of teaching.

In our society teachers are thought to be infallible, students believe unconditionally what their teachers tell them. Students never challenge their teachers; teachers are not forced to prove they are correct. This is, perhaps, because people are not supposed to question authority, we are to take what they say as a truth.

Is an authority always correct? Should people just believe what they are told and not question things? In the IMP program students are expected to question everything. The IMP students never just believe what a teacher says; they always want to know why and how something works. When a student asks why, the teacher responds by asking what the students think. Most of the time students end up answering their questions. They are forced to think about something and draw conclusions from their own ideas. These conclusions are not always correct, but students learn to be critical thinkers and they become confident in their work. IMP students are confident enough in themselves to ask questions and mathematically competent enough to answer them.

Most of IMP problem solving is done in teams, students are constantly working together to solve problems. There is occasionally a problem with students straying for the task; they are high school students who love to socialize, it only takes a look or comment from the teacher to get them back to the assignment. In the IMP program groups change frequently to ensure that students learn to work with people who have different problem solving skills as well as different personalities. The groups usually work very well together, sometimes there will be a group that has some personality conflicts and the group will not be as productive. This occasional clash of personalities is resolved by the frequent changing of the teams. Group work is an essential part of everyday life, when a problem arises it never gets solved by one person, any number of people work together to find a solution. When IMP students finish the mathematical sequence they have a strong advantage over their peers who took traditional mathematics classes, they have the skills and the knowledge necessary to work with others in order to solve problems.

The typical day in an IMP classroom begins with a discussion of the previous night homework assignment. This discussion can be one in which the whole class participates or a few students will present their solution to the class. When the entire class discusses the homework it tends to take longer, but the teacher can see if most of the class is grasping the concept. The students will be actively participating in the activity, the discussion will become detailed and usually questions will be asked to delve deeper into the information.

I could not assign the homework based upon whether or not I thought they were valuable assignments. The class had to

complete certain assignments in order to follow the set curriculum. I have included a few examples of IMP homework assignments. For the IMP year one class this homework assignment (appendix A) entitled "The Basic Student Budget" deals with students who have to pay rent at the end of the month. Three students who share an apartment receive their pay at the beginning of the month and must have enough money at the end of the month to pay the rent. The students are expected to solve this problem graphically. At three time intervals the amount of money each boy has left is given to the students in a chart. The class will graph this information and decide whether or not the boys have enough money to pay their rent. There is an added twist to the problem, can the boys afford to go to a thirty-dollar concert and still be able to pay their rent on time. This is a useful problem because in the students' near future they will begin to pay their own bills including rent.

An example of an IMP year two assignment (appendix B) has also been included. This assignment is entitled "Not a Sound" the problem is one involving surface area. Pearl plays her music too loudly and wants to soundproof her room. The question requires students to measure a box-shaped room in their house and calculate how much soundproofing material will be needed to cover the four walls, the ceiling, and the floor. This assignment will help students if they ever want to redecorate their homes.

Both of these homework assignments are problems the students may someday have to deal with. Although the second assignment is a surface area problem, that word is never mentioned and the formula is never given. Students are frequently asked to find a pattern and derive a formula on their own. This is what makes parts of the curriculum difficult for students; they must come up

with ideas and formulas on their own, but once they derive these formulas they are not easily forgotten.

Everyday students complete an in-class assignment; this assignment is completed in their teams. This is when most of the presentations take place, teams will work on the problem, and then all or several of the teams will present their solutions. These solutions are not always correct, sometimes the students will miss a small detail about the problem and sometimes their solutions are completely incorrect. These mistakes are not distressing; they show the teacher what aspects of the material must in covered in greater detail. Mistakes are a natural part of the learning process; they learn from their errors and come away with more knowledge than they started with.

I have also included several class work assignments. The first is from IMP year one (appendix C), it is entitled "Water Conservation" this assignment also requires students to solve a problem graphically. The students are given a situation in which three families start with an amount of water and the amount of water the families drink per day. The students are to compute how much water the families have left in three days, eight days, twelve days, and X days. This is a real world problem will someday help students that want to travel, to ensure that they back enough supplies.

I have also included from year one "Getting the Gold" this class work assignment (appendix D) is about gold mining. It begins by describing two methods of gold mining and gives the cost of the materials needed to search for gold. It also gives what the worth of a once of gold was and the average amount of gold a person could mine using both methods on a given day. The goal of this assignment was for the students to compute the

miners profit for each method after five, sixteen, and thirty days. Students were also asked to decide how long it would take the miners, using both methods, to break even. It is also asked for the students to calculate when the miners start to make a profit. This situation is a real world problem because it deals with expenses, losses, and profits. It is a cost analysis problem and the students have the knowledge to decide which mining method will make the most money.

There is also an IMP year two class work assignment (Appendix E) included in this report. The assignment is entitled "The Ins and Outs of Boxes". This assignment is the conclusion of a unit, it is asking the students to sum up what they have learned in previous assignments. They are asked to fill in two charts one for surface area and one for volume. Then the students are asked to find a formula for surface area and volume. This is an innovative way to present geometry, the students first complete several assignments on the material and after that they are asked to come up with a formula. This is very different for the traditional geometry class in which students are first given formulas and then asked to solve problems.

In the traditional class students are not asked to think about how to do something they are told how and then given problems to demonstrate they were paying attention. I have included all of these exercises to show that real world problem can be solved in order to learn traditional mathematics topics. This innovative approach to mathematics shows students that the information learned in class can be applied to their daily lives.

Students also demonstrate the concepts they have grasped by completing problems of the week (POW's). These are assigned to the class in order for the students to use outside information

and skills to solve a long-term problem. These problems cannot be completed in an evening, it is intended for the students to work on over an extended period of time. These POW's are also based on real-world situations. I was able to assign and correct a POW while I was teaching at Wachusett High School. This POW used students' knowledge of area to make several sized patches for a quilt. An interesting part of every POW is the students get to evaluate the assignment. Most of the assignments that were handed in were very well done, and I was able to see that material can be presented in an alternative manner and the concepts can be learned.

I spent twelve years in a traditional mathematics classroom, and I am currently working towards a Bachelors of Science in Mathematics. I was able develop a love for mathematics in the traditional classroom, most students in the traditional mathematics class never develop a passion for the subject. They take three years of math in high school in order to graduate. Students in the IMP program not only begin to develop a love of math they also begin to develop a love of knowledge. One of the best questions ever asked in the classroom is why. If you want to know why something works you have an obvious interest in the material and you will work to find and answer to that question. This cycle of questions and answers trains people to become life-long learners. Students in the IMP program ask why. The teacher will ask the students questions in order to get them thinking in the right direction. Most of the times when students ask a question, with the proper direction, they can answer that question themselves. When the students answer their own question they become more confident in themselves and their work.

Another aspect of the program that I enjoyed is the teamwork. The students develop a more personal relationship with each other. They work together on assignments, if one student is struggling with a problem another student can help them with it. This peer interaction helps the struggling student to understand the concept while the other student strengthens what they already know. There are times when a person in your peer group can explain something better than the teacher can. As a teacher it is very difficult to not tell a struggling student the correct way to answer a problem, they get frustrated and want to give up. The encouragement they get from the teacher and their peers helps them in their quest for a solution. The look on the student's face when the "light bulb goes on" is one of the best things a teacher could ever witness.

I did not know all of these things on my first day in front of the class. I was very nervous and the boisterous freshman knew it. I wasn't only a student teacher I was a very young looking teacher, so young in fact that on my first day I was asked several times for a hall pass. The previous night I had a restless night's sleep. I was worried my cooperating teacher wouldn't like me, and that my students wouldn't respect me. The major worry that kept me tossing and turning all night was what if I wasn't any good at teaching. All of these doubts and fears came back into my head as my lesson began. Yet I was determined to not let my students be in control, I was in charge of the class and I wanted to establish that in the beginning. I choked down my fears and doubts and began to teach the lesson.

On the first day the freshman tested their limits. They wanted to figure out exactly what they could get away with, and I was even more determined to establish that they weren't going to

get away with much. I was the teacher, the authority figure and I knew if I let them run the class the first day they would want to run the class the entire time I was teaching. The first day was rocky. I was nervous, they were childish. I tried to teach, but they wanted to socialize. I assigned homework, no one heard me. This cycle continued with the freshman for a few days until they realized I was there not to baby sit but to teach.

My first day with the sophomore class was a slightly different story. They too tested their limits, but for a shorter period of time. For the first part of the class I explained why I was at Wachusett High School. I felt it was a good way for the students to get to know me. They were interested in my research and several students had questions about it. After my brief introduction we forged ahead and I began to teach that days lesson.

The days with the freshman wore on and I became more and more frustrated with the class. My cooperating teacher gave me a piece of advice I will always bring with me into the classroom: "Half of teaching is acting, it you are excited about the material the class will get excited about the material." I took his advice and applied it to the next day's lesson. He was correct, I was excited to teach the lesson and my students also got excited. I used this trick for the remainder of my time at Wachusett and became more in more successful at teaching my lessons. As I got to know the freshman I learned how to handle them, they are young and need to be occupied at all time; if they aren't their minds tend to wander. There were days when I wanted to leave the class and never come back, but the days when they work well made it worth all the aggravation.

The sophomore class was a friendly and supportive environment. They wanted to learn and were willing to work. The students had respect for me as well as respect for each other. The teamwork was remarkable. If a student was struggling with something and I was not available to help another team member would offer to explain it. I looked forward to teaching that class everyday. They were far more mature and I found that I could let them explore problems for longer. The freshman strayed from a task quickly; at times they were more interested in each other than their work. This is when I realized I had to approach the classes differently. The sophomores were good at working to solve a problem together. I allowed them to spend more time discussing problems as a team. The freshman could talk about problems together, but I found that a whole class discussion was a better teaching method. This method allowed me to know who understood the material and it kept the whole class on task.

On my last day at Wachusett High School I was sad to go. I had grown to like most of my students. My time at Wachusett was short but I learned an immense amount teaching, students, and myself. Teaching is an art, an art that I did not perfect in eight weeks. It is an art that takes years and years of experience to perfect. I know that all students learn and act differently and as a teacher you must learn how to approach each student in order to reach him or her. Most importantly I learned that I could become a good teacher. Although my first day was rocky by my last day I had control of the classes and I felt as thought my students were learning. The one question I have yet to answer, is a teaching career in my future? Maybe.

VI. Personal Opinions

Before I left Wachusett I asked my students what they thought of the IMP program, here are some of their responses:

Courtney Jeffcoat of the IMP year one states: "I like this class because in order to do good you need to try. It encourages you to think. I love working in teams." Emmanuelle Martin of IMP year one says: "I like it (IMP) because it is not as boring and I find the problems have something to do with real life situations. In the long run I think more people will be better at learning math through IMP. Diana Rolashevich also of IMP year one says: "I think that IMP is a good class to take, you work as group instead of always working by yourself. You have group discussions instead of lectures. I think that this is a good way of learning and more classes should be like this."

I also got the views on the program from IMP year two students this is what they had to say. Deborah Kerr states: "I really enjoy the IMP program. As a student who formerly struggled in math classes, I have found a new appreciation for math. The IMP program teaches in an integrated way helping the students to apply mathematical concepts. The concepts learned are remembered much easier because everything builds on everything else." Kim Convery had this to say: "I think IMP is a better way of applying math to the real world. It gives us real world situations to remember traditional math problems." Kate Holden said this: "I like IMP because we learn by figuring it out on our own, and not from formulas. Some people may not get a lot from IMP because you get what you put in. If you want to succeed in IMP you will. I like how we work in teams because we can learn from other people. I think when we leave the IMP program at the end of high school, I will have learned

information that is useful and more meaningful than I would have learned in a traditional class."

Not all the responses I received were as positive, but overall the classes I taught felt as though they would take with them more knowledge from an IMP class than a traditional class.

Education reform is a big issue and I have seen first hand that change is difficult and takes time. People who have taught the same way for many years find it difficult to change their teaching methods. As a student teacher I spent time in the teachers' lounge and I was not afraid to ask teacher what they thought about education reform. Most teachers agree that reform is necessary how to change the system was a question that caused a great deal of discussion. On one particular day I asked about the heterogeneous classroom. Several teachers had very strong opinions about the subject; most of which were that it wouldn't work. One teacher felt that she would have to "water down" her curriculum if students of all abilities were in the class. She didn't think that lower ability students could read some of the novels her higher ability students could read. This is a valid concern, but I believe changing her curriculum to meet the needs of all of her students could solve this problem. It is difficult to tell a teacher who has been teaching for twenty or more years that there is a better way to do their job.

Through my research and my short time teaching at Wachusett High School I have developed several thoughts of my own on education reform. The system of education currently in place is in need of a change. Teachers must be held responsible for their students, they must be willing to go the extra mile to help and encourage their struggling students while at the same time stimulating the higher ability students to probe deeper into a

problem. Class size needs to be smaller; students and teachers need to develop more personal relationships. If teachers know a student they know how a student learns and in what way to present material in order for the students to attain more knowledge. I have also seen that a heterogeneous classroom can work without leaving the slower students behind and the faster students will not be bored. It is imperative to keep all students on task so that they can learn more. If a student is interested they are working. Students can no longer be hand fed information, they must begin to think for themselves and find solutions to problems on their own. A classroom must become more like a place for open discussion and less like a lecture hall. Students should be encouraged to ask questions and then even encouraged to answer those questions on their own. A students peer group is also an important of education, at times a fellow student can explain a concept better than the teacher; students should be able to discuss problems with each other in order to find a solution.

VII. Conclusions

As part of education reform the state legislature as well as the department of education wanted to test students in the forth, eighth, and tenth grades. These tests were used as a measurement of the students' knowledge as well as a measurement of the school districts educational system. Students in the tenth grade are not allowed to graduate until they pass this basic skill test known as the MCAS. The results from the first MCAS test were disheartening to many people; people wanted to know why the students performed poorly. Parents blamed the school system, the school system blamed poor government funding, and Massachusetts's citizens blamed students, teachers, and parents. The validity of the test was questioned. According to a Boston Globe article printed on December 8, 1998 three graduates of the Massachusetts Institute of Technology who currently teach science at Boston Latin think the designers of the MCAS created an invalid test. The three teachers took the test, focusing on the tenth grade science, multiple choice section. They "object to a significant number of the questions because some have no correct answer, multiple possible answers, ambiguity in wording or are irrelevant." They continue to state:

"If more than one-third of the multiple choice questions are suspect, how can one ever validate the test? Why are we labeling students, teachers, and schools as failures based on a poorly written test?"

For a long time the MCAS results and education reform were huge stories in the media. Not everyone believed that education reform was working. An editorial written by Jeff Jacoby, a Globe columnist was printed in the Boston Globe on December 14, 1998. The title of his column is "The meaning of the MCAS:

Education reform is dead." This article has strong opinions about education reform, in the third paragraph of that article he states: "Money rained down on the very people who had wrecked the schools in the first place. Five years and $5 billion dollars of education reform later, the students are as ignorant as ever."

The two above-mentioned articles have included because it is important to understand that everyone has an opinion about the system of education. Some want to keep the same system that has been in place for hundreds of years, and others want to make radical changes to the system. Due to the change in society the way we teach America's children must change, however five years and a sum of money can't change every thing. Further more one test is not a good measure of what the students have learned nor is it a good measurement of teachers abilities. Change takes time and money and if educators are given the resources they need to make these changes the leaders of the twenty first century will become the leaders of the world. Students must be given the opportunity to thrive and teachers must be given the resources to help students achieve all of their goals. Change is a difficult process but now it is a necessary one, the changing times must be reflected in the nation's school system. The nation must draw upon all the information available and change the education to meet the needs of students in our new technological society.

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Homework 17 The Basic Student Budget

Cal, Bernie, and Doc are college students on basic student budgets.

Sometimes the three have a little difficulty keeping to their budgets. Their biggest problem is the rent.

The total rent for their apartment is $450, which is split evenly among the three roommates. The rent is due on the last day of each month, and the guys don't get paid until the first day of the next month.

Their landlord has no tolerance for late payments.

Continued on next page

Each of the three students had a different amount of money after being paid on April 1. At the end of that day, Cal had $550, Bernie had $400, and Doc had $300. As the month goes by, they each make note occasionally of how much they have left at the end of the day.

The table shows their records so far.

Amount of Money Remaining (in dollars)

Date	Cal	Bernie	Doc
April 3	498	383	285
April 10	352	349	245
April 17	220	313	215

1. Sketch and label a graph that accurately represents this situation. (Show all three students *on the same graph*.)
2. Who will be able to pay his rent on time and who will not? How do you know?
3. It's April 21, and there's a great concert on campus. This would be an extra cost, beyond the three students' normal expenses. How much, if anything, can each one spend and still have enough for rent money on April 30?
4. Suppose each of them starts May with the same amount with which he started April.

   Find an approximate rule for each roommate that will tell him how much money he should expect to have at the end of the xth day of May if his spending habits don't change.

Appendix B

Homework 22 Not a Sound

Pearl was tired of hearing "Turn that music down!" every evening, so she decided to soundproof her room so that she could listen to her music uninterrupted.

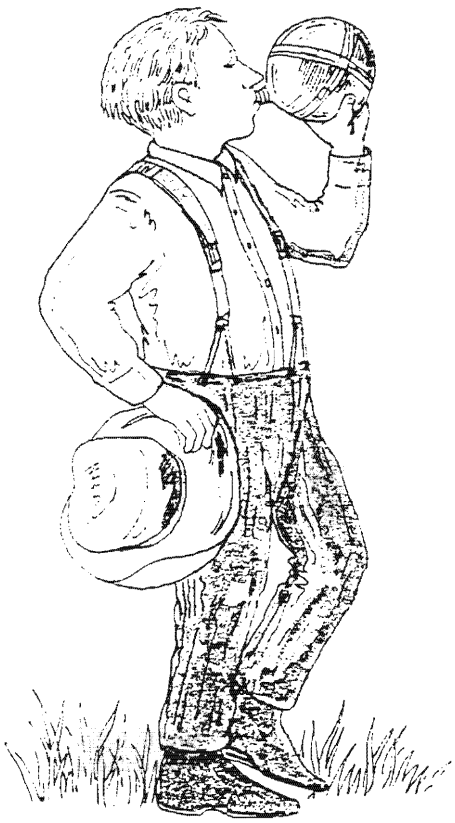
Soundproofing material is sold in flat sheets that can be attached to the walls. Pearl decided to put soundproofing on the floor and ceiling too, just to be on the safe side.

1. What if you wanted to soundproof a room where you live? Choose a box-shaped room and figure out how many square feet of soundproofing material you would need to soundproof it. Explain the process you used to figure out your answer.
2. Explain how this problem is related to the unit problem about bees and their honeycombs.

Water Conservation

Nevada seemed like a desert to the emigrants, who had been following large rivers most of the way from Westport. As you have seen, water was a very precious commodity on the Overland Trail, and travelers had to be careful not to run out.

They kept track of their water use, planning for the next opportunity to refill their water containers.



1. The Stevens family had a 50-gallon water container. In an effort to conserve water, they reduced their daily consumption to three gallons per day.

   If they began with a full container, how many gallons of water would they have left after three days? Eight days? Twelve days? X days?

2. The Muster family was larger. They had a 100-gallon water container. Their daily consumption was eight gallons per day.

   If they began with a full container, how many gallons of water would they have left after three days? Eight days? Twelve days? X days?

3. Use your answers to the last part of Questions 1 and 2 to graph each family's water supply. Use *number of days* for the horizontal axis and *amount of water left* for the vertical axis. Graph both functions on the same set of axes.

4. Is there a time when both families would have the same amount of water left? If so, when would it happen and how much water would both families have at that time?

5. In how many days would each family run out of water?

Appendix D

Getting the Gold

Many of those who made the long trek to California were in search of gold. Though few were able to get rich, many tried.

One of the most common ways to get gold was to pan for it in streams.

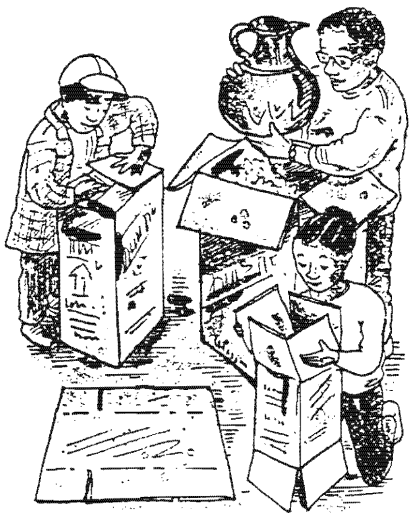
To pan for gold, all a person needed was a $9 shovel, a $50 burro, and a $1 pan. A person could get an ounce of gold each day, on the average, by panning.

One ingenious person discovered a way to get gold from a stream by using a trough. The trough was a long chute that miners set in the stream and rocked back and forth to separate the gold from the silt of the stream.

Although it was more expensive to get started with the trough method, that technique produced about twice as much gold each day as the pan method. To use a trough, a person needed a team of two burros, a shovel, and a trough. The trough cost $311.

At that time, gold was worth $15 an ounce. The following questions involve the amount of profit (income minus expenses) from each method after a certain number of days. (A loss of money is considered a negative profit.)

1. How much profit will each method yield after 16 days?
2. How much profit will each method yield after 30 days?
3. How much profit will each method yield after 5 days?
4. Make two graphs on the same set of axes: one graph should show the profit from panning; the other should show the profit from using a trough. (The horizontal axis is the number of days.)
5. How many days will it take for a miner using each method to break even?
6. After how many days will the two methods yield the same amount of money?



The Ins and Outs of Boxes

In *Flat Boxes,* you found the surface areas for two different rectangular solids. To find those surface areas, you needed to know the dimensions of the solids—their lengths, widths, and heights.

In this activity, you will look at how to calculate *both* the surface area *and* the volume of a rectangular solid when you know its length, width, and height. You should use the centimeter as the unit of length, the square centimeter as the unit of surface area, and the cubic centimeter as the unit of volume.

1. Enter the information from *Flat Boxes* in an In-Out table like this one.

In			Out
Length	Width	Height	Surface area

2. Find the volume for each figure from *Flat Boxes* and enter this information in an In-Out table like the one here.

In			Out
Length	Width	Height	Volume

3. Find rules for each of these two In-Out tables. Use the letters l, w, and h to represent the length, width, and height, and use S and V to represent the surface area and volume. Your goal is to express S and V as functions of l, w, and h. You may want to examine more rectangular solids in order to get more rows of information for your tables.

   Note: The formula for the second table is easier.

4. Justify any formulas you found in Question 3.