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Virtual Learning Project

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VIRTUAL LEARNING PROJECT

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Virtual Learning Project

An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
Degree of Bachelor of Science

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ABSTRACT

This project aims to utilize the power of virtual learning and social networking to help reduce high school drop-out rate and increase college entrance quota. In the pre-study, two sample MCAS exams, along with online review lectures, were given to high school students to investigate the relevance of virtual learning to high school education. The students' points of views toward college education and their network of academic support were inquired in a separate survey. The result provided valuable information to design Tootor.org with exclusive features to help high school students improve their academic performance, build meaningful connections with college students, and eventually consider college as their next natural stop.

ACKNOWLEDGEMENTS

AUTHORSHIP PAGE

       At the time of the submission of this report, it is difficult for us to identify the specific responsibility of each member of our team attributed to this document. We have worked together and traded responsibilities, which makes individual contributions no longer apparent. The report has truly become a unified team effort.

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EXECUTIVE SUMMARY

Tootor.org is a mentoring and teaching non-profit website specifically designed to encourage and support high school students, especially those at risks or with disadvantaged background. Instead of focusing only on academic support, the website ambitiously aims to inspire high school students with unfiltered experiences shared by college students.

Tootor.org also aims to make the college entrance more accessible to any students wishing to make a successful transition from their high schools. Though people might achieve their success without college degrees, college education still remains as an important stepping stone to a more financially secure and stable future in the community. However, many students still drop out of their high schools or not pursue their college path, due to their lack of ability, or awareness about the college experience. As of 2006, there were 17.5 million high school students in the US with approximately 20 percent drop-outs and 30 percent of high school graduate population did not enter college (Current Population Report, August 2008). The need to decrease high school drop-out rate and increase college entrance rate is definitely there for Tootor.org to embrace.

As a free virtual learning and counseling website, Tootor.org follows the motto "amplify need and focus help," aiming to encourage students to seek as much help as possible from the vast automated resource built on the site. The project applies many innovative approaches to develop a fun, appealing and rewarding virtual learning environment for high school students.

CHAPTER 1: INTRODUCTION

Taking advantage of the World Wide Web's tremendous networking power and adopting strategies of established websites, Tootor.org aims to create a network of college volunteers to help high school students, especially those at risk or with limited means, fulfill their potential. Instead of focusing only on academic support, the website ambitiously strives to inspire high school students with unfiltered experiences shared by college students.

Tootor.org distinguishes itself as a unique mentoring and teaching website for high school students for the following reasons.

Tootor.org provides a unique way to mastering basic math and science, which is an essential part in high school education. Before Tootor.org, there are many existing dedicated online learning websites created for educational purposes. However, those websites did not achieve the original objective because of several major issues. First, interactions between lecturers and students or among online users are minimal, which limits students from active learning. Second, the content is non-appealing and alienating to a large population of students, especially those from disadvantaged background. Third, mental support is not emphasized or in most cases absent altogether at these websites. Tootor.org is designed to overcome these limitations.

Educating is a social activity and educational networking is potentially the next natural evolution in education. For those reasons, one of the most important goals of the project is to create an educational network among high school students and between high school and college students through various forums, Facebook pages, and online chatting service. Through this network, Tootor.org hopes to diminish the image of college as a highly privileged and

strictly academic environment and replace it with a vision of challenging but exhilarating life changing experience.

Tootor.org gives students motivation to expand their knowledge. Besides highly motivated college bound students, Tootor.org aspires to bring the rest of the students to the table with a network of college mentors who do not only teach certain subjects or relate certain college experiences but also serve as attainable role models. In addition, weekly competitions in the form of educational games are promoted to encourage students to actively study the materials.

The project's short term strategy is to launch the website with the specified features, recruit contributions from college students, and attract participation from high school students. The long term strategy involves providing a free prolonged mentoring service for the students, creating a sustainable advantage by establishing a stable financial resource for the website and constantly making significant improvements in products and services based on feedbacks from the users and volunteer tutors is a priority. Tootor.org will use its closed ties with students from Worcester Polytechnic Institute, Massachusetts Institute of Technology, Harvard University and Stanford University to develop high-end applications and tools that are both educational as well as entertaining.

In summary, Tootor.org strives to be the educational network where high school students, especially those with limited means, can get solid mental and academic guidance as well as valuable social connections that will last a life time.

CHAPTER 2: BACKGROUND/LITERATURE REVIEW

In this chapter, we will provide a literature review of the different aspects of free public education for secondary students. The first section presents a general description of the traditional academic setting. The second section presents a new model of free public education which is virtual academic setting. Finally, we will express the area of improvement.

2.1 Traditional Academic Setting

In this section, we will first provide the general information about high school- the fixed model of traditional academic setting and the learning challenges usually experienced by high school students. We will then present a quick report of the dropout rates followed by its implications. At the end, we will review the government policy created to improve the high school graduation rate.

2.1.1 High School

"High school" is a term widely used in United States referring an institution that provides basic knowledge for students to prepare for their future paths, especially for colleges or associated institutions. Depending on the State, high schools include students from 9th or 10th to 12th grade (TeensHealth, 2009).

There are many different types of high school that serve different purposes. These include: general high schools which focus on different types of education, vocational high schools which focus on the career aspect of education, college-preparatory high schools which

prepare students for college and special high school is the school for students with special educational needs due to severe learning difficulties (TeensHealth, 2009).

These schools offer a wide range of educational opportunities for students: college-preparatory classes for advanced students, general classes for average students, and remedial classes for those who are struggling. The subjects covered in high school are also broad from science, mathematics, and engineering to art, foreign languages, and social sciences. With a large variety of subjects to choose from, students can liberally select different courses according to their own abilities and interests. Generally, the basic requirement to graduate high school is to successfully complete 3 years of English, 3 years of Mathematics, 3 years of Science, 3 years of Social Science, and 1 year of Foreign Languages (Witmer, 2009).

2.1.2 Learning Challenges in High School

Many high school students experience hard time keeping up with school work. This period may last several days to weeks or even throughout one's entire high school life. (Focus Adolescent Services, 2008) The reason for these learning challenges is unfathomable to identify; however, the most reasonable explanations are failure to make the transition from middle school to high school, deficient basic academic skills, and lack of engagement (National Middle School Association (NMSA), 2006).

Most of freshmen find the transition to high school the most difficult thing to do because they experience high school as a larger, more impersonal, competitive and grade-oriented environment than middle school. Therefore, they fail to adapt to the high school environment and perform poorly in classes (Mizelle, 2000). Consequently, many freshmen drop out, often shortly, after they enter high school, or they fall behind and fail to graduate on time (National Middle School Association (NMSA), 2006).

Deficient basic academic skill is also a reason for high school hardship. Because high school education is a cumulative process, or in the other words, high school education resembles a chain, one missing link can damage the whole sequence. In a report of Florida Center for Instructional Technology, students who lack basic mathematical skills experience challenging time with higher level mathematical materials (Florida Center for Instructional Technology, 2010).

Lack of engagement is another reason for learning dilemma. A research of Indiana University shows that students who could not find engagement with the materials tend to pay less attention and gradually perform poorly in class. This research also indicates that 73 percent of students who dropped out did not like the school, and 60 percent of them did not see the value in the school work (Yazzie-Mintz, 2007).

2.1.3 High School Dropout

High school dropout is considered one of the biggest problems worrying the United States (US) Department of Education for years. Despite the fact that the percent of high school dropouts decreases over the years, the rate is still significant. In Massachusetts, the percentage of students who dropped out from high school in 2006-07 was 3.8% and this number slightly decreased in 2007-08 to 3.4 %. In a recent report of U.S. Department of Education in 2009-10, the percentage of high school dropouts was down to 2.9 %. This statistic to some extent brings hopes for the US Department of Education, showing that there could be possible improvement in both teaching and studying styles (Guarino, 2009).

According to another report in 2008 of Massachusetts Department of Elementary and Secondary Education, the tendency of dropping out seems to be consistent through all the grades in high school even though the dropping out percentage of sophomore is the highest

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(26.7%) compared those of freshmen (24.1%), junior (23.8%), and senior (25.3%) (Guarino, 2009).

Status dropout rates of 16- through 24-year-olds in the civilian, non-institutionalized population, by race/ethnicity 1980-2009
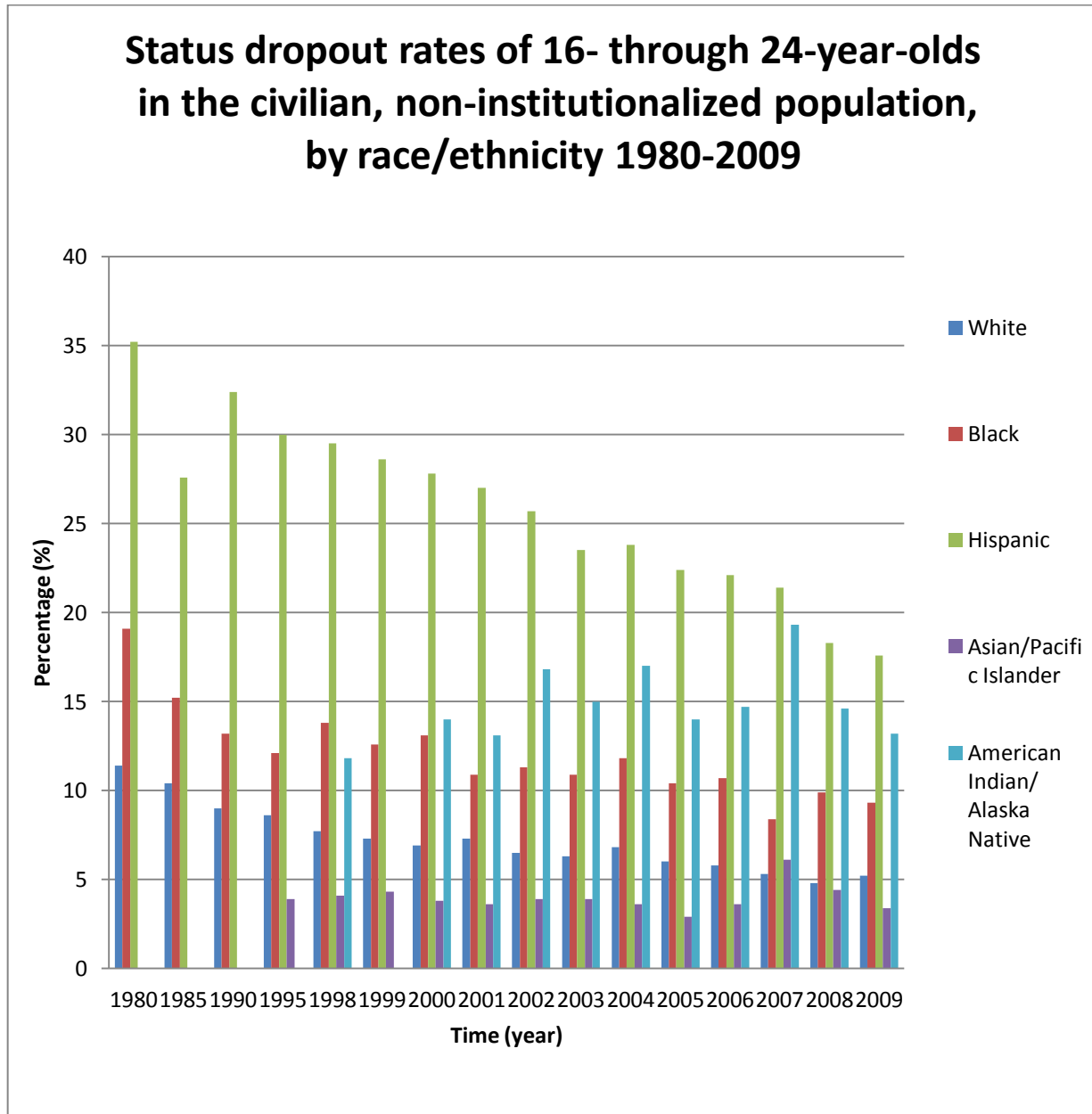
Figure 1: Status dropout rates of 16- through 24-year-olds in the civilian, non-institutionalized population, by race/ethnicity: 1980-2009 (Generated by data from U.S. Department of Education, 2010)

Figure 1 shows the percentage of high school dropouts varies from different races and ethnicities. Since 1980 to 2008, the dropout rates for Hispanics are the highest. In 2009-10, the percentage of dropouts is highest for Hispanics (17.6%) and lowest for Asians (3.4%). Nevertheless, the dropout rates for Caucasian, African Americans, and Hispanics each declined between 1980 and 2008 (U.S. Department of Education, 2010).

2.1.4 Cost for Dropping out from High School

Dropping out from the high school has negative impacts on a person's life, family and even to the nation. According to a report from Alliance for Excellent for Education (AFEE), the consequence of this decision is shocking. Table 1 clearly indicated that over the course of one person's lifetime, the one who dropped out of high school earns about $260,000 less than a high school graduate on average (Alliance Excellent for Education, 2009).

Moreover, dropping out from high school not only affects the individuals themselves but also the communities, states, and country they live in. AFEE calculated that dropouts from the Class of 2008 alone will cost the nation more than $319 billion in lost wages over the course of their lifetimes. AFEE also indicated, if dropouts of the Class of 2006 had graduated, the nation could have saved more than $17 billion in medical aids and expenditures for uninsured health care over the course of those young people's lifetime.
 If the graduation rates of Hispanic, African American, and Native American students are raised to the levels of White students by 2020, the potential increase in personal income would add more than $310 billion to the U.S. economy. Increasing the graduation rate of male students in the United States by just 5 percent could save the nation almost $8 billion each year by reducing crime-related costs (Alliance Excellent for Education, 2009).

	Estimated Additional Lifetime Income If High School Dropouts Graduated With Their Class in 2006-2007[1]			
States	9th Graders (2003-2004)	Estimated Graduation Rate (2006-2007)	Estimated Number of Dropouts for the class of 2007	Total Lifetime Additional Income if Dropouts Graduated
Alabama	62,718	59.0%	25,714	$6,685,738,800
Alaska	11,803	65.1%	4,119	$1,071,004,220
Arizona	87,576	68.4%	27,674	$7,195,244,160
Arkansas	37,301	72.2%	10,370	$2,696,116,280
California	528,564	70.7%	154,869	$40,266,005,520
Colorado	63,312	74.6%	16,081	$4,181,124,480
Connecticut	48,643	79.8%	9,826	$2,554,730,360
Delaware	11,009	62.0%	4,183	$1,087,689,200
District of Columbia	5,656	58.2%	2,364	$614,694,080
Florida	253,565	60.5%	100,158	$26,041,125,500
Georgia	135,091	56.1%	59,305	$15,419,286,740
Hawaii	16,459	64.1%	5,909	$1,536,283,060
Idaho	20,771	77.0%	4,777	$1,242,105,800
Illinois	174,343	75.7%	42,365	$11,014,990,740
Indiana	85,025	70.9%	24,742	$6,432,991,500
Iowa	40,486	81.1%	7,652	$1,989,482,040
Kansas	38,684	74.4%	9,903	$2,574,807,040
Kentucky	54,730	70.0%	16,419	$4,268,940,000
Louisiana	58,514	61.4%	22,586	$5,872,465,040
Maine	16,891	76.2%	4,020	$1,045,215,080
Maryland	78,690	74.7%	19,909	$5,176,228,200
Massachusetts	83,759	73.2%	22,447	$ 5,836,327,120
Michigan	153,567	69.1%	47,452	$12,337,572,780
Minnesota	69,744	78.7%	14,855	$3,862,422,720
Mississippi	39,536	62.1%	14,984	$3,895,877,440
Missouri	77,175	75.0%	19,294	$5,016,375,000
Montana	12,915	76.2%	3,074	$799,180,200
Nebraska	24,374	79.8%	4,924	$1,280,122,480
Nevada	34,779	54.0%	15,998	$4,159,568,400
New Hampshire	18,286	76.0%	4,389	$1,141,046,400
New Jersey	108,480	82.5%	18,984	$4,935,840,000
New Mexico	29,840	60.1%	11,906	$3,095,601,600
New York	257,475	65.0%	90,116	$23,430,225,000
North Carolina	122,508	66.1%	41,530	$10,797,855,120
North Dakota	8,952	79.4%	1,844	$479,469,120
Ohio	160,873	74.7%	40,701	$10,582,225,940
Oklahoma	49,529	70.4%	14,661	$3,811,751,840
Oregon	46,213	71.1%	13,356	$3,472,444,820
Pennsylvania	162,097	78.2%	35,337	$9,187,657,960
Rhode Island	14,188	70.6%	4,171	$1,084,530,720
South Carolina	69,415	53.8%	32,070	$8,338,129,800
South Dakota	10,375	78.5%	2,231	$579,962,500
Tennessee	79,195	72.2%	22,016	$5,724,214,600
Texas	377,912	67.3%	123,577	$32,130,078,240
Utah	36,028	83.8%	5,837	$1,517,499,360
Vermont	8,422	81.0%	1,600	$416,046,800
Virginia	107,033	73.1%	28,792	$7,485,888,020
Washington	88,869	66.5%	29,771	$7,740,489,900
West Virginia	23,723	71.7%	6,714	$1,745,538,340
Wisconsin	77,798	77.3%	17,660	$4,591,637,960
Wyoming	7,346	75.8%	1,778	$462,210,320
United States	4,190,237	69.9%	1,265,016	$328,904,058,340

Table 1: Estimated Additional Lifetime Income if High School Dropouts Graduated With Their Class in 2006- 2007.

2.1.5 Government Policy to Improve Graduation Rate

In order to reduce the dropout rate in high school, aids from the government are necessary. Over the past few years, the government has created several programs to reduce the high school dropout percentages. A variety of activities have been designed to provide junior high students and their parents with useful information about the high schools and offer the students necessary social support during the transition from middle school to high school.

Middle schools have frequently taken their students to fieldtrips to different high schools to help them observe and be familiar with high school environment. In addition, after-school programs have been created to help remedial students with their school work and improve their academic standing in preparation for new challenges in high school. Many clubs and organizations in high school, such as robotic club or aerospace club, are encouraged to demonstrate the link between high school education and fascinating real-life applications.

The nation also has invested a large amount of financial support and resource to these programs. In 2009, President Obama has made the funding worth 3.5 billion dollars for the high school with the graduation rate below 60% to support educational equipment and programs (The White House, 2011).

2.2 Virtual Academic Setting

Beside traditional education, virtual education may propose an alternative approach to improve high school graduation rate. In the following section, different aspects of virtual learning, including its history, distinguished characteristics, and recent milestone in the field of education will be explored.

2.2.1 Definition of Virtual Education

Virtual education, sometimes referred to as virtual learning or online learning, is one of the most critical educational tools in the past several years. Nowadays, computer technology has been developing dramatically. This change has significantly impacted many aspects of education. A virtual education is a learning environment where teachers and students are separated by time, or space, or both. The teachers provide the course content through the use of informative technologies such as the internet or videoconferencing. Students receive the material and communicate with teachers on the same platform (Weller, 2007). Consequently, a virtual learning environment refers to a set of teaching and learning tools designed to enhance student's learning experience by including computers and the Internet in the learning process.

There is a clear distinction between online and offline learning. Offline learning is the traditional method of learning where students pick up knowledge from direct interactions with their parents, teachers, or from their own experience, etc. Online learning is the method of learning that students can study remotely over the internet. Thus the differences between online learning and offline learning are the interactions among teachers and students, and the separation between them (Weller, 2007).

2.2.2 Brief History of Virtual Education

Virtual learning environment emerged about the same time when computers, emails and remote conferencing were developed. Essentially, the practice of distance learning existed almost 100 years prior before the invention of computer. In 1840s, there were classes that were being offered by correspondence courses through the mail in England (Moore & Kearskey, 2005). This type of educational program became increasingly popular through the improvement of the postal service. Television, video recorders, and even radio have made a contribution to distance learning. Since computer was invented, distance learning has made major improvement. Distance learning eventually earned the name "e-learning".

Many online courses marked the beginning of e-learning era. In 1971, Open University, the world's first university to teach only at a distance, admitted more than 24,000 students in its first year. Students learned from specially-produced textbooks, TV and radio programs, audio and video tapes, computer software and home experiment kits. Now, Open University becomes Britain's largest single teaching institution. More than two million people have taken its courses since 1971. In 1989, University of Phoenix (UOP), the fifth largest private university in the United States at the time, had launched its online program. Now UOP Online program offers 14 undergraduate, 22 graduate and 4 doctoral degrees (Erthal, 2005). A brief timeline of virtual education's history is indicated in Table 2.

Table 2: A brief history of virtual education (Weiss, 2006)

YEAR		EXAMPLE
1861	*Telegraph is Invented*	
1876	*Telephone is Invented*	
1969	*Computer data networking is Invented (ARPANET)*	DARPANET/ARPNET
1971	*Email is Invented*	
1971	*Computer Conferencing is Invented*	1971
Mid 70's	University Courses are Supplemented by Email and Conferencing	
Mid 70's	Virtual Communities of Practice	Scientists use EIES to collaborate
1981	First Totally Online Courses (Nonformal, Adult Education)	The Source; EIES
1982	First Online Program (Executive Education)	● WBSI Executive Education (EIES)
1983	Networked Classroom Model Emerges (Primary and Secondary Schools)	● ICLN Research Project in 4 Countries ● RAPPI: Canada X-Cultural Project I Countries ● SITP (1990)
1986	First Totally Online Undergraduate Classroom	● Virtual Classroom (NJIT)
1985	First Totally Online Graduate Courses	● Connect-Ed (New School of Social Research)
1985	First Totally Online Labour Education Network	Solinet (Canadian Union of Public Employees)
1986	First Online Degree Program	● Connect-ED (1986) ● 1989 University of Phoenix
1986	Online Professional Development Communities Emerge	● OISE Ontario Educators Online Courses
1989	*Internet Launched*	
1989	First Large Scale Online Courses	● Open University (U.K)
1992	*World Wide Web is Invented*	● *CERN (Switzerland)*
1993	First National Educational Networks	● 1993 SchoolNet (Canada)
1996	First Large-Scale Online Education Field Trials	● Virtual-U Research Project

2.2.3 Major Aspects of Virtual Learning

Internet and social networking websites are the two most prominent tools of virtual learning. The first provides universal access to virtual learning environment, while the later serves as a powerful promotion gadget to raise awareness among general public about the available sites.

Nowadays, the Internet is popularized throughout the world. Documents could be stored over the Internet and shared among different people. In the era in which communication and exchange of information are the golden keys to success, the Internet has proved itself as one of the powerful tools in many departments. Virtual education is another one of them. It takes optimal benefits from the power of internet to establish its unique characteristics. Virtual education provides both teachers and students with great degree of freedom to optimize their time and virtual experience on the selected subjects.

The graph below shows the numbers of Internet users per 100 inhabitants during the year of 1997 to 2007 of three groups: the developed world, the developing world, and the world globally. This graph indicates that the numbers of Internet users of all groups are increasing every year; the developed world especially has the greatest number of Internet users per habitants among them. The situation clearly reflects the increasing percentage of the population having access to the Internet each year, making virtual learning environment more accessible as well (International Telecommunication Union, 2011).

Internet users per 100 inhabitants 1997-2007 (Source: ITU)
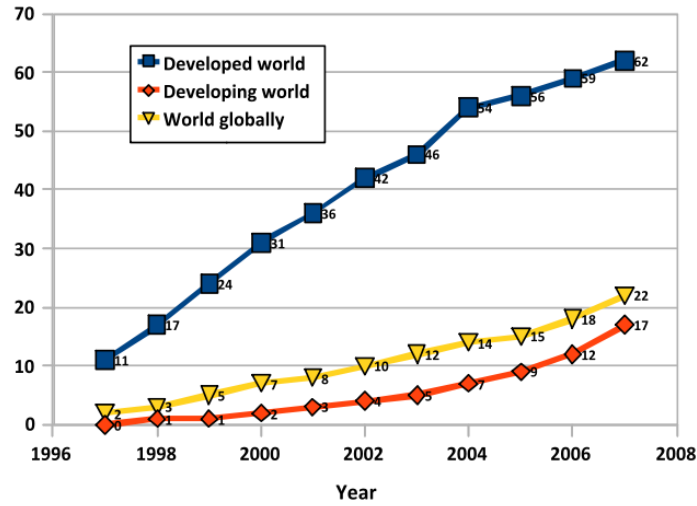
Figure 2: Graph of Internet user per 100 inhabitants between 1997 and 2007 by International Telecommunication Union (ITU) recreated in Open Office Calc.

Social Networking is one of the most crucial applications of Internet in the 21st century. It emphasizes on creating and developing social connection between friends and associates in a virtual environment. Online communities of Internet users who share similar interests have grown significantly stronger in the past few years thanks to social networking's power. Most notable social network sites include Facebook, LinkedIn, Twitter, and Youtube in certain aspects. Recent years have witnessed significant developments of virtual learning sites thanks partially to the promoting power of social networking. Such partnership suggests a promising direction to upgrade the scale of virtual education among Internet users (Siemer, 2008).

2.2.4 Contemporary Epitome of Virtual Education

With respect to the current number of users, the amount of investment, popularity among the media, and the prospect for future development, Khan Academy and Assistments top the list of the most successful virtual learning websites.

Khan Academy—Khan Academy is a not-for-profit website aiming to deliver a world-class education to anyone anywhere. It has attracted more than 18 million followers. Led by Khan, a

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Harvard graduate, the website provides a huge number of lectures on various topics, from mathematics, chemistry, and physics to finance and history. Currently, there are more than 2,100 videos and 100 self-paced exercises that have been delivered to learners. During his first years, Khan has well taken advantage of Youtube, a form of social media to popularize his lecture videos to the general public. Now sponsored by the Bill & Melinda Gates Foundation, Khan Academy is well on its way to revolutionize the whole educational system (Khan Academy, 2011).

Assistments— Created by Professor Heffernan at Worcester Polytechnic Institute, Assistments is a web-based tutoring program for 4th to 10th grade mathematics. It is a large database with about 60,000 exercises that are the valuable practice source on mathematics and science for students. The goal of the website is to provide the students with a well-established set of math and science skills so that they can succeed at their current level and higher academic grades. Assistments requires the students to enroll in specific classes and use the system through their teachers. The teachers are given permission to track their students' progress and offer help appropriately. It is an exclusive and powerful tool in the aspect of improving connection between teachers and students. With 10 million funding from the government, Assistments has rapidly expanded the program to several high schools in the US, aiming to help millions of students in need (Desmaris, 2011).

2.2.5 Benefits of Virtual Education

There are several benefits to virtual learning that we may not find in offline learning. Unlike a stand-alone brick and mortar school, a virtual school is located online; it will not be closed during the nights, weekends, or holidays. Therefore, teachers and students can have

access to the school 24 hours a day, 7 days a week. In addition, they can virtually attend the classes from the comfort of their own home, backyard, or office. Through a virtual learning network, people can have or hold jobs while continuing their education. Some students who are full-time employees are unwilling to attend college or graduate school full time since they will lose their earnings and their seniority. Virtual education gives them the option of keeping their jobs and still attending college (Aniston, 2007). Additionally, students save money: they do not need to spend their budgets on commuting when education is now accessible from home.

Moreover, whether students are fast, average, or slow learners, taking an online class let them work at their own pace. If a fast learner wants to finish the class earlier, they can do so. At the same time, slower students may take more time to review the lecture and finish the assignments when they feel ready to. Moreover, if students do not fully understand the lectures, they can easily review the lectures as many times as they want since the materials are available online.

There are also some students who live far away from the stand-alone brick institutions. These students may not be able to attend the formal education they want. Online schools give those students the equal chance as the others, as long as they have access to a computer and an internet connection. It does not matter at all whether students live in different provinces; different countries, or different continent (Malloch, Cairns, Evans, & O'Connor, 2011).

2.3 Area of Improvement

Advancements in the field of virtual education have been the subjects of several

studies. Researchers often combine new models into the existing platform of virtual learning in

order to optimize its potential. One of the most significant and promising improvement in the

field is edutainment. Derived from online gaming, the innovation aims to direct gamer's energy

for educational purpose (Asgari & Kaufman, 2004).

2.3.1 Computer/Online Game Definition

A game is a collection of voluntary activities which has participants, goals, rules, and

some kinds of physical or mental competition. The game usually involves some characteristics

of competitions, including those with one self (Asgari & Kaufman, 2004). A computer game is

a game using electronic devices such as personal computers as a medium. Along with the

development of computer games, dominant internet usage in recent years has supported

tremendous growth of a new division of games named online games. It is generally defined as

multimedia applications that are played in networked virtual environment such as internet or

LANs; it includes the following characteristic features: anonymity, real-time interaction,

information exchange and entertainment (Wu, Wang, & Tsai, 2010).

2.3.2 Motivation in Online Games

According to Yee et al., there are three major factors that contribute to motivation in

online games: the achievement component, the social component, and the immersion

component. The achievement component includes the desire to gain power, the interest to

analyse the underlying rules, and the drive to challenge and compete with other. The social

component emphasizes on the personal interest in communicating with others, the need to

establish a long-term meaningful relationships, and the satisfaction of being part of group efforts. The immersion component is derived from self-enjoyment on the basis of self-improvement and escapism. In conclusion, the players use online environment to create for themselves a second persona with different, sometimes more enriched background, knowledge, connections and mission (Yee, 2007).

2.3.3 Limited Success of Edutainment

The term "edutainment" was coined to describe forms or methods of entertainment applied for educational purposes. Edutainment and instructional computer games were thought be a promising resource since it could simultaneously entertain and educate. However, it in turn received bad reputation in both fields of education and pure game design for the following reasons. In edutainment games, drill and practical knowledge are often labelled as games. Pre-determined content subsequently lowers the thinking skills and decreases the users' interest into the games. That edutainment makes minimal attempts to teach gamers how to analyse their understanding, synthesize their perceptions, and develop their learning - a fatal mistake of most of the products in the genre (Charsky, 2010).

CHAPTER 3: PROJECT DESCRIPTION

Though several researches have well demonstrated the significance of virtual learning, our team decided to perform an independent study to evaluate more objectively its impact on high school education. In this session, detailed descriptions of the pre-study and collected data would be presented. Information derived from the study would play a major role in determining future features of Tootor.org.

3.1 Pre Study

In order to study the effectiveness of virtual education and investigate high school students' attitude toward college education and virtual education, the IQP group initiated a pre-study with Doherty Memorial High School (DMHS) in Worcester, MA. Preliminary data from the study provide important foundation for future direction of the project.

3.1.1 Participants

Doherty High School counselors and the Tootor.org team mutually agreed on Memorandum of Understanding (APPENDIX A) which clearly indicated responsibilities of both sides. The team was given permission to perform the study and collect data as long as personal information was kept confidential. Based on availability of teachers and students at DMHS, Tootor.org team recruited a total of 54 high school students from freshman to senior in three different class periods with age ranging from 15 to 19 to participate in the research. At the second round of evaluation, due to objective reasons, only 48 students of the initial group remained in the study.

The pre-study required the usage of two sample math tests that resembles the Massachusetts Comprehensive Assessment System (MCAS) test (APPENDIX B&D) and a survey designed by the Tootor.org team (APPENDIX C). There were 17 problems in each test, with 10 multiple-choice questions - each worth 1 point, 3 free response questions - each worth 2 points, and 4 fill-in-the-blank ones, 1 point each. The total score of each test was 20 points.

For the purpose of measuring the student's improvement, the second test was designed in a way that it closely resembled the first one: the test structure remains the same for both tests while the numbers are different.

Eight short videos (approximately 10-minute clips) from Khan's Academy website (APPENDIX E) were selected based on their relevance to the randomly chosen test topics. The videos were shown to the students during their class time using a projector.

3.1.3 Tasks and Method

First, all of the students were asked to complete the first sample math test (APPENDIX C) in 50 minutes. Within two weeks after the first test, they were asked to watch Khan Academy videos (APPENDIX E), the content of which was closely related to a selected set of questions in the test materials (number 2, 3, 9, 10, 12, 13, 15, and 17). They were then asked to complete the survey (APPENDIX B).

After two weeks, the second test (APPENDIX D) was given to the all participants. Finally, statistical data and information were collected and recorded by the Tootor.org team and the original graded sample tests were returned to the students.

It is hypothesized for the pre-study that the high school students will make statistically-certified improvements in the questions 2, 3, 9, 10, 12, 13, 15, and 17, for which they were shown relevant videos from Khan's Academy website.

3.1.5 Results

The sample tests were graded based on a pre-determined rubric. Student T-test was performed on the questions 2, 3, 12, 13, and 15. Questions 9, 10 and 17 were excluded from the analysis because the first one had a typo, while the other two had a significantly higher level of difficulty than the rest of the test. On the other hand, the responses from the survey were summarized and illustrated in the pie charts.

3.1.5.1 MCAS Sample Test Results

The average scores, along with standard deviation (SD), of sample test I (pre-test) and test II (post-test) of question 2, 3, 12, 13, and 15 were evaluated using Excel and summarized in Table 3 below

Table 3: Results of MCAS sample test on questions 2, 3, 12, 13, and 15

Question/Subject	Length of Videos (mins)	Maximum Score	MCAS Sample Test I (pre) Mean(SD)	MCAS Sample Test II (post) Mean(SD)
Q2: Solving equation	9:12	1	0.31 (0.469)	0.44 (0.501)
Q3: Slope	4:40	1	0.56 (0.502)	0.75 (0.438)
Q12: Slope	4:41	1	0.24 (0.432)	0.54 (0.504)
Q13: Area of triangle	10:46	1	0.04 (0.191)	0.08 (0.279)
Q15: Solving equation	9:12	2	0.09 (0.401)	0.21 (0.410)

In order to better illustrate the data in Table 3, a graph comparing average scores of each question was generated and shown in Figure 2 below.
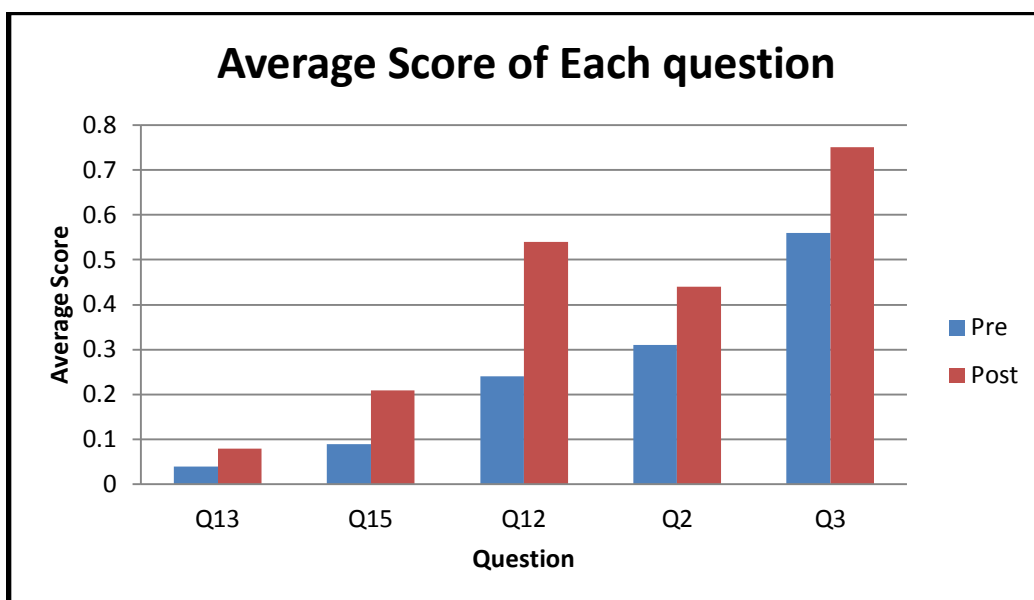
Figure 3: Average Score of question 2, 3, 12, 13, and 15

Figure 2 indicated that there was increase in the average scores of questions 2, 3, 12, 13 and 15. However, the difference was not significant enough to draw any conclusion from the figure. A Student's t-Test was necessary to determine any statistical difference between two sets for data in each question. The Null Hypothesis would be: There is no statistically significant difference between two sets of data. The chosen alpha value would be 0.05 or 5%.

Table 4: T-value from Student's t-Test for questions 2, 3, 12, 13 and 15

Question	Length of Videos (mins)	Pre Mean(SD)	Post Mean(SD)	t-value	*p-value*
Q2: Solving equation	9:12	0.31 (0.469)	0.44 (0.501)	1.985	0.206
Q3: Slope	4:40	0.56 (0.502)	0.75 (0.438)	1.984	0.039
Q12: Slope	4:41	0.24 (0.432)	0.54 (0.504)	1.986	0.002
Q13: Area of triangle	10:46	0.04 (0.191)	0.08 (0.279)	1.989	0.337
Q15: Solving equation	9:12	0.09 (0.401)	0.21 (0.410)	1.984	0.154

The p-value for the Student's t-Test of question 2 was 0.206, which was much greater than the alpha value 0.05. Hence, the null hypothesis should be accepted: there was no

statistical difference between the scores of the first and second tests on question 2. Similarly, the p-values for student's t-Test of questions 13 and 15, which were 0.337 and 0.154, respectively, strongly reflected that the test scores in the first and second sample tests on these two questions showed no statistical difference.

On the other hand, the p-value of question 3 and 12 were 0.039 and 0.002, respectively, which were well below than the alpha value of 0.05. Thus, the null hypothesis could be rejected: there was a statistical difference between the scores of the first and second tests on question 3 and 12.

The p-values and the conclusion for the null-hypothesis of each question were summarized in Table 6 below.

Table 5: Conclusion for Null Hypothesis with respect to the alpha value of 0.05

Question	Length of Videos (minutes)	p-value	Null-Hypothesis
Q2: Solving equation	9:12	0.206	Accepted
Q3: Slope	4:40	0.039	Rejected
Q12: Slope	4:41	0.002	Rejected
Q13: Area of triangle	10:46	0.337	Accepted
Q15: Solving equation	9:12	0.154	Accepted

In conclusion, with question 3 and 12, it could be declared with 95% confidence that students would make statistically-certified improvements after they were shown relevant videos from Khan's Academy website.
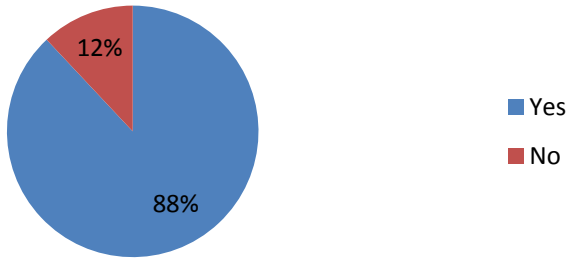
3.1.5.2 Survey Results

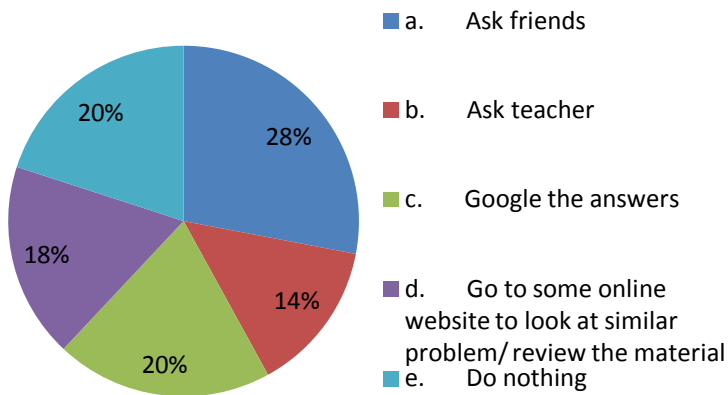**Figure 4: "Question 1: Do you have a computer/laptop at home?"**

Figure 5: "Question 2: What do you do when you get stuck with your homework?"
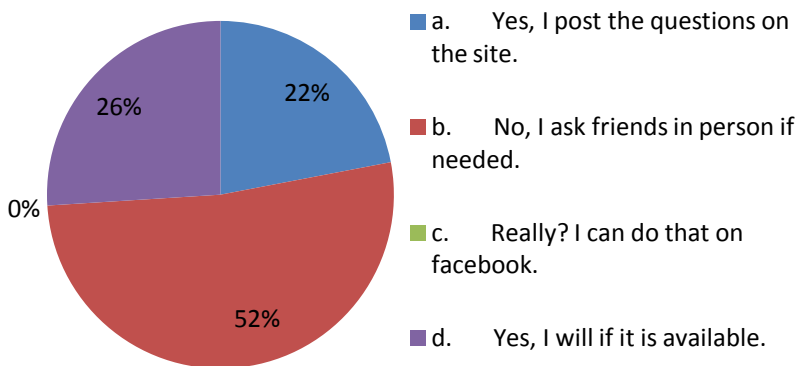

Figure 6: "Question 3: Have you ever used facebook to exchange or discuss with your classmates or friends about the homework?"

Figure 3 demonstrated that the majority of participants could use computer or laptop at home, which was the first crucial step to gain access to virtual learning. The next seven questions in the survey, questions 2-8, focused on studying the extent of virtual education at which the students engaged in.

As shown in Figure 4, when the students needed help for homework, there was an equal distribution of resources they approached: friends, teacher, Google search, and online website. 20% of students chose not to ask for help. Though there was a slightly higher percentage of students who chose to "ask friends" for homework help (28%), no available resource appeared to be preferred over the others.

In addition, when asked whether they seek academic support from social network such as Facebook, the majority of the students (52%) rejected the idea and preferred to ask their friends 'help directly as shown in Figure 5. Only 22% supported the usage of Facebook; however, it was important to note that 26% of the students considered it a possibility if an existing page or platform on Facebook were set up for them.
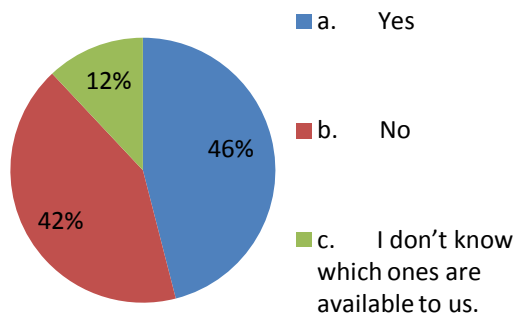
Figure 7: "Question 4: Have you ever gone to an online site to watch lecture videos or review class materials?"

Figure 8: "Question 5: What do you think that can help you to do well on homework/ tests?"

Figure 9: "Question 6: What do you think about the idea of studying math in form of online games?"

Figure 6 reflected that approximately half of the participants came to an online website to watch lecture videos or review class material while the other half did not consider it an option. There was a small proportion of the participants (12%) indicated their interest but lacked the knowledge of a good resource to access.

Question 5 in the survey asked the students the most important resource for academic success. As shown in Figure 7, most of the students (38%) chose asking teacher and there were equal percentages of students who preferred working in a group and reviewing with a good friend, 26% and 24% respectively. A smaller percentage of students (12%) voted for using online resources.

On the other hand, there was a clear division in the students' opinions about the prospect of studying math in form of online games: 50% of them rejected it, 42% welcomed the idea while the rest (8%) was unsure.
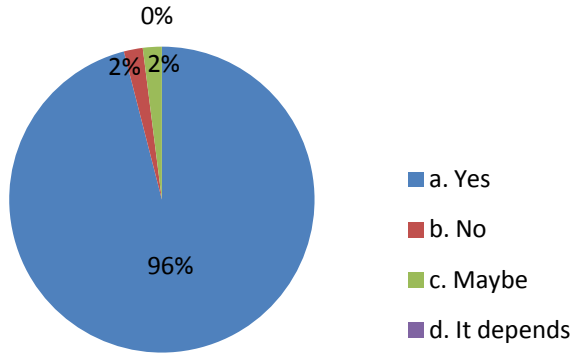
Figure 10: "Question 7: Do you want to go to college?"
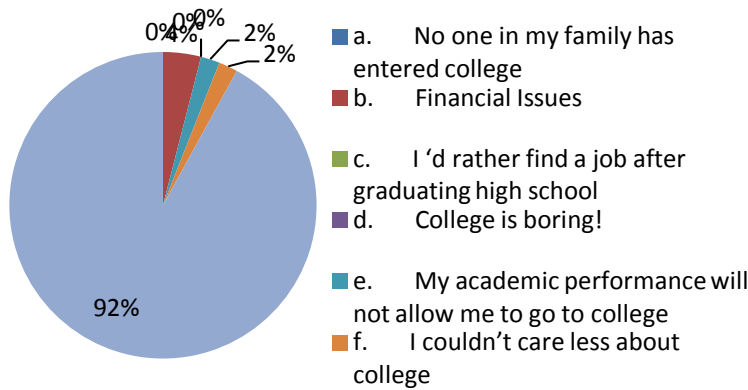
Figure 11: "Question 8: If you answer "No", "Maybe", or "It depends" to question 7, please explain below"
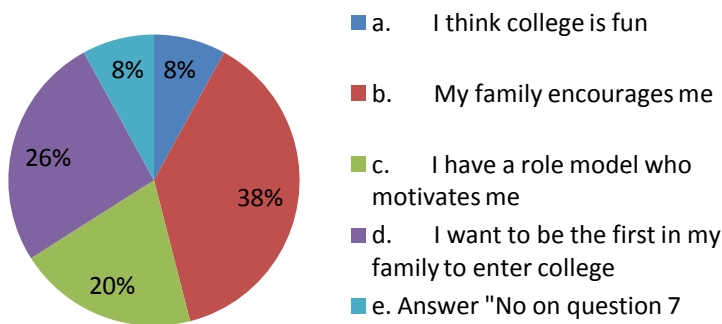
Figure 12: "Question 9: If you answer "Yes" to question 7, please explain"

Question 7-9 emphasized on studying high school students' attitude toward college entrance. A greater number of high school students (98%) wanted to enter college while the remaining 4% was either unsure or opposing to the option. Figure 10 reflected that the students did not want to enter college due to a variety of reasons: financial issue, unsatisfactory academic performance, and lack of motivation. Similarly, there were many explanations for the pursuit of college education as demonstrated in Figure 11: thought of college as a fun environment, encouragement from a role model, inspiration to become the first one in the family to enter college, and most notably, support from family.

a.	Too long, I fell asleep after 5 minutes.
b.	Too short, I wish it was longer.
c.	It is perfect. I like all of those lecture videos.
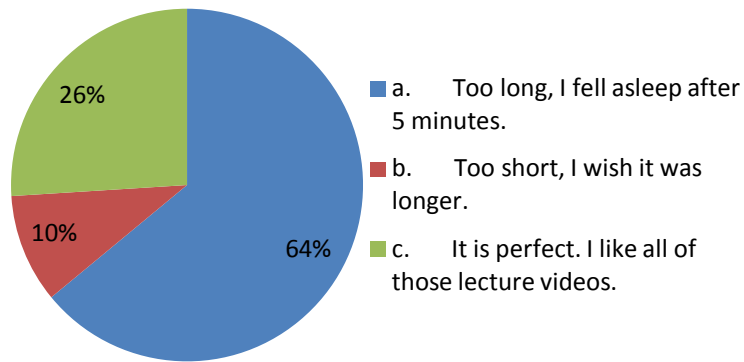
Figure 13:"Question 10: What do you think about the lecture videos? "

The last question in the survey was to study the ideal length for lecture videos. As shown in Figure 12, most of the students (64%) thought that the videos were so long while only 10% regarded them as too short and a moderate number of students were satisfied with the length of the video.

3.1.6 Discussion

Based on literature review, the project started a pre-study to examine the effectiveness of virtual learning on high school education. Using one of the most well-known virtual learning websites, Khan's Academy, as review resource, the pre-study expected to witness the improvement of high school students' performance in a mathematical exam. The experimental data, however, only partially supports the hypothesis. Though the mean score of the students in the tested questions all went up, the p-values from Student's t-Test confirmed that there was no statistical difference between two sets of data on questions 2, 13 and 15 while the p-values in question 3 and 12 supported that there was a statistical improvement in the scores of the first and second tests (Figure 6).

It is also important to take into account lengths of the videos on Table 6. The review videos of questions 3 and 12 were less than five minutes long while those of questions 2, 13, and 15 were more than nine minutes long. This may imply that the students scored better on

35

the questions reviewed with the shorter video. In order words, there may be a correlation between the length of the video and the students' improvements.

The hypothesis that virtual learning in form of online review videos could help high school students improve their academics accomplishment was only partially supported in the study. Further studies are required to test the hypothesis, as well as, clarify this connection between the length of lecture videos and its effects on students' performance. Several limitations which would be discussed in later session could provide a valuable guideline for further studies.

The survey provided a good outline of the participants' point of view toward virtual learning and college education. The response highlighted the contribution of both traditional schooling and virtual learning in high school education even though the later one, in some extent, was more favoured by students. Collected data suggested that high school students came to their friends or teachers to ask for academic support more often than explored other options in the world of virtual learning. However, an adequately large proportion of students have well taken advantaged of online learning resource, while the group of unsure students did not show prejudice toward virtual education. They left the option open and displayed willingness to participate, especially when there was a platform appropriately designed for them.

A noteworthy fact shown in the survey was that a large proportion of the high school students mentioned working with friends as a good method to achieve academic advancement. This suggested that social networking factor of virtual learning, if well-designed, could help the students maintain such connection in a virtual environment. Based on the feedbacks from final questions of the survey, the ideal range for lecture video should be from 5-8 minutes,

which was sufficient to deliver useful information and, at the same time, attract high school students within their short attention span.

The later part of the survey identified several factors that influenced high school students' decision to enter college. Support from family or role model provided the greatest motivation for high school students to seek advanced degree; similarly, lack of precedent in the family could discourage students to continue their education. The data demonstrated that motivational issues always propose major obstacles in the process of transitioning from high school to college.

3.2 Tootor.org

Based on the data and survey collected on the pre-study, the prototype of Tootor.org was constructed in June, 2011. The sole purpose of the prototype was to collect initial feedbacks for future development. Preliminary results from the pre-study, along with continuing feedbacks from users and visitors, have been helping the team improve and upgrade the site until official launching at the end of the year 2011.

3.2.1 Prototype
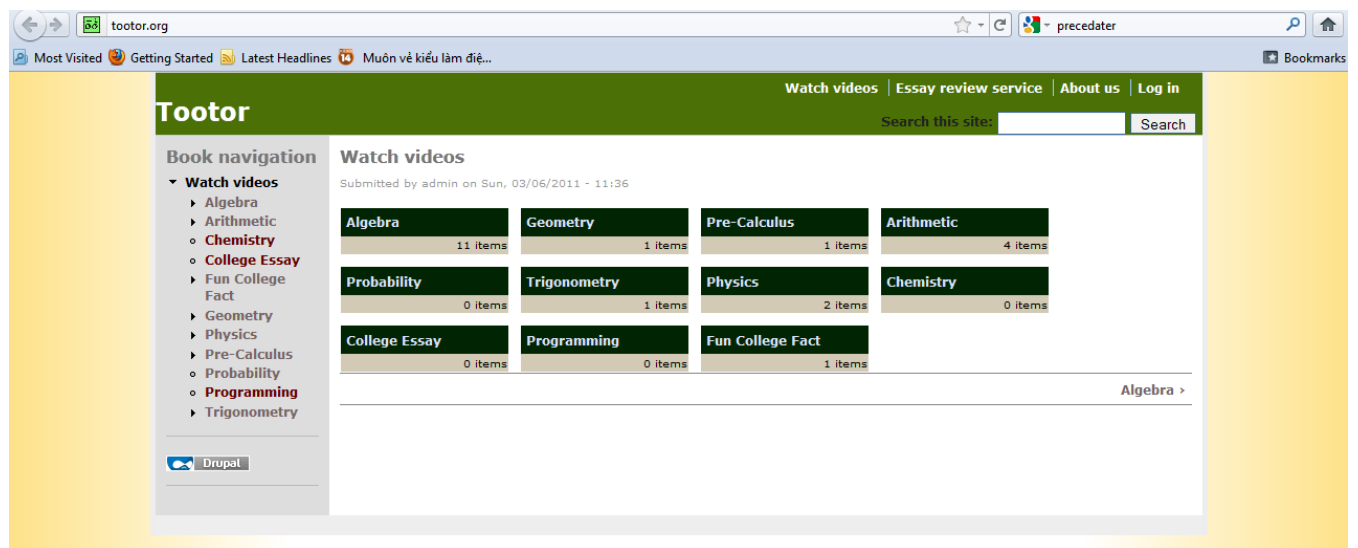
Figure 14: Tootor.org Prototype Captured on October 2nd, 2011

3.2.2 Basic Functions

Based on the data from pre-study and current resource of the Tootor.org team on budget, staff size, and technology, the following functions have been installed for the website:

- *Online Lecture Videos*: The site currently hosts 20 lecture videos created by college students. With the current rate of recruitment and contribution from existing tutors, the site may reach 100 videos in the upcoming month. The lecture topics include various divisions

of Maths, Physics, Chemistry, and Programming. The length of the video varies from 7-10 minutes and each video has an outline to help the students follow the lecture more easily. Though pre-study strongly indicated that 10 minute was a relatively long span compared to the high school student's attention period and 5 minute would be an ideal length, it was necessary to cover the majority of each lecture topic and more convenient for the tutors. Shorter videos (5-7 minutes), along with more knowledge checkpoints, are being installed by the site.

- *College Essays & Essay Review Service*: College students will post their admission college essays in order to help high school students establish general ideas about the expectation and format. In addition, high school students could upload their potential college essays at this section and receive feedbacks or comments from college tutors. It should be noted that the website has been developing during the admission season. The specified functions do not require much engineering work, and they just depend on a small team of recruited writing tutors. They propose one of the most practical ways to support the students during this critical period, and, at the same time, increase the site's popularity among high school students.

- *Fun College Video*: This category hosts videos from fun college events. It emphasizes the exhilarating and exciting aspect of college life in hope of helping high school students to find the motivation to start a new chapter of their life. As emphasized throughout the literature review and reflected by the data in the pre-study, motivation plays an important key in changing the high school student's outlook on college education; therefore, it remains a recurring theme of the website.

- *Online Community*: The site is hosting forums and in the process of developing online chat service in hope of building meaningful connection between college and high school

students, or among high school students. As illustrated in the pre-study, a high percentage of high school students liked working with friends and often sought guidance from teacher. So by building strong online community, encouraging group work, and enhancing connection between high school and college students who had lived through the transition from high school to college, Tootor.org hopes to help the users achieve academic advancement and learn the significances of college education.

CHAPTER 4: CONTRIBUTIONS

The results showed positive effects of virtual learning on academic performance of the participants. The implication and benefits this project on the social scale, or more specifically on resolving the urgency of high school drop-out, is undeniably extensive. This study provides solid framework for future research on the pro and cons of virtual education and its application on improving high school educational experience.

Mediocre academic performance and lack of motivation have caused the high school students to lose interest in college education. If Tootor.org could recruit help from a large number of college students and provide high school students with a free and accessible virtual learning tool which targets these two issues, college education could become more approachable than ever. Starting from the primary research, Tootor.org strives to expand and become the leading mentoring website for high school students. The project's mission is to help high school students, especially disadvantaged one, to actively engage in academic activities and seriously consider college as the natural next stop in their journey. Tootor.org want to reform the virtual learning experience from a rigid academic structure to a natural and fun social activity that all high school students can share with their friends without fear of being excluded. Making a real change requires true collaboration between the students and their mentors. The project counts on the input of the students to formulate the nature of an effective collaboration.

CHAPTER 5: LIMITATIONS

There are several limitations in the pre-study conducted in this project. First, the participant's pool was relatively small and not sufficiently diverse. All of the students were from Doherty Memorial High School, Worcester, MA; therefore, the data could not be generalized for all high school students in the Commonwealth of Massachusetts. In addition, the participants were consisted of sophomores, juniors, and seniors whose levels of math may vary greatly to begin with. Besides the lecture videos, there were so many other factors that could influence the interpretation of the data.

Secondly, the nature of the lecture videos also raised multiple issues. Since at the time of pre-study the team did not have defined lecture, Khan's Academy videos have been used. The videos did not reflect every aspect of virtual learning and only two out of seven give videos were shown to help students improve their test scores. However, it remained as a critical evaluation tool. Feedback on the length and the content of the videos provided invaluable information for future development of website.

Thirdly, due to conflicts in the participants' schedule, there was a long delay (approximately one week) between the time the review videos were shown to students and the time they took the second test. The gap could have caused the students to forget the content of the videos and not perform well in the selected questions. In order to evaluate better the effects of the lecture video, such long delay should be prevented in future research or the videos should be shown with higher frequency during the period of time between two sample tests. More rigorous longitudinal study with multiples points of collecting data could also offer a solution to the problem.

Fourthly, the given questions had different levels of difficulties and a typo occurred in one question. Such variation could not provide a sufficient base line to evaluate the results. Though it is challenging to level the difficulty of the given questions, such factor should be taken into account more actively in future studies.

Finally, further breakdown of the test scale score and the survey's response may help provide a better picture of the pre-study. Since most of the questions were multiple choices, the students could get either 0 or 1 point for each question. In case the videos helped improve certain aspects of the students' math skills, the limited score could not reflect it; even a minor mistake could cost the students the whole point of the question. Similarly, the survey could be improved with a wider range of answers, for example, from "strongly agree" to "strongly disagree", to reflect more suitably opinion from the participants.

CHAPTER 6: FUTURE STEPS

The prototype of Tootor.org should be developed further with the addition of the following functions.

- *Revised Lecture Video and Exercise:* Short questions will appear at the end of the lecture and require students' input to check their knowledge of the presented subject. These checkpoints are designed to make student pay more attention to the lecture's content. "Cool" videos and collection of mnemonics closely related to the subject are included to raise curiosity among the students. Direct links from each lecture topics will lead to exercise section which includes specific questions corresponding to each subject.

- *Online chatting:* Online chatting is a synchronous method implemented to help students in real-time setting. Students are encouraged to ask questions concerning academic problems, college admission, standardized tests, etc. At the primary stage, online chatting will be available once a week. As the need and available resources increase, online chatting will be held more frequently and organized into distinct catalogues: subjects (math, physics, chemistry, etc.), college application, and college life.

- *Games:* Educational games will be designed and weekly contests with prizes will be held to investigate the role of online game and group work in virtual learning environment.

Data collected from the prototype and user's feedback could help provide directions for future development of the site. Once the project obtained a sufficient number of lecture videos, another study could be performed with a larger and more geographically diverse pool of high school students. Limitations from the pre-study would be taken into account in order design a

better approach to test the possibility of using virtual learning site, more specifically

Tootor.org, on resolving the high level of high school drop-out.

APPENDIX A: MEMORANDUM OF UNDERSTANDING BETWEEN DOHERTY

MEMORIAL HIGH SCHOOL AND TOOTOR GROUP

COOPERATIONAGREEMENT

Between

Tootor IQP Project Team Non-profit Organization (408)-202-5494

-of-

Worcester Polytechnic Institute

100 Institute Road, Worcester MA 01609

-and-

Judy S. Fairfull

Head Guidance Counselor-Doherty High School

Acting Guidance Liaison-WPS (508)799-3277

-of-

Doherty Memorial High School

299 Highland Street, Worcester MA 01610

THE COOPERATION AGREEMENT is here by executed on //.

<u>Background</u>

1. Tootor.org is an IQP project initiated by four WPI students. The website serves both as free learning resource and a social network which stimulates and supports students' interests to studying Math and Science.

2. Initial study with Doherty Memorial High School's student could assist tootor.org to establish a solid background to distinguish itself from other virtual learning resources optimize its benefit to high school students.

3. Doherty Memorial High School is the public high school located in Worcester. It has diverse student bodies with different academic levels-about 1,600 students, in grade 9 to 12.

4. Doherty Memorial High School was selected as the first testing location because of the use MCAS as a standard test to evaluate students' level and the convenient transportation and communication means.

IN CONSIDERS of the mutual benefit and responsibilities specified in this AGREEMENT, the sufficiency of which consideration is hereby acknowledged both parties to this Agreement as follows:

<u>Commencement Date and Term:</u>

- The Tootor.org team will commence the tutoring service with Doherty High School starting on March3, 2011 until May2, 2011.

<u>Tootor.org Team Commitment:</u>

- Tutor twice a week: 2-3PM on Thursday and Friday.
- Provide Doherty Memorial High School with Beta Version of tootor.org by May5, 2011

<u>Doherty Memorial High School's Contributions:</u>

- Persuade students to attend scheduled tutor hours.
- Recruit sufficient number of students in math classes to take sample math test and do the survey prepared by the Tootor.org team on a scheduled date. The format of the test will be take-home and be due within3 days.
- Assign a selected group of the volunteer students to watch specific videos from Khan's Academy website at home.
- Ask the students who take the earlier test to do another take-home examine order to evaluate improvements.

BOTH PARTIES ACKNOWLEGE THAT THEY HAVE CAREFULLY READ THIS

PROPOSAL AND AGREE TO ALL OF THE PROVISIONS IN THIS AGREEMENT

Doherty Memorial High School

_____

Date:

By: Judy S. Fairfull, Head Guidance

Counselor-Doherty High School

Tootor IQP Team

Date:

_____

By: Ngoc Do

Date:

_____

By: Khanh- Nhan Nguyen

Date:

_____

By: Tran Nguyen

Date:

_____

By: Patchara Santawisook

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APPENDIX B: VIRTUAL LEARNING/COLLEGE INTEREST SURVEY

This is an anonymous survey. Your answers will be kept confidential

1. **Do you have a computer/laptop at home?**

   a. Yes

   b. No

2. **What do you do when you get stuck with your homework?**

   a. Ask friends

   b. Ask teacher

   c. Google the answers

   d. Go to some online website to look at similar problem/ review the material

   e. Do nothing

3. **Have you ever used facebook to exchange or discuss with your classmates or friends about the homework?**

   a. Yes, I post the questions on the site.

   b. No, I ask friends in person if needed.

   c. Really? I can do that on facebook.

   d. Yes, I will if it is available.

4. **Have you ever gone to an online site to watch lecture videos or review class materials?**

    a. Yes

    b. No

    c. I don't know which ones are available to us.

5. **What do you think that can help you to do well on homework/ tests?**

    a. Review with a good friend

    b. Solve problem together in a group before the exam

    c. Look for more online problems to practice with

    d. Go to the teacher and ask for his/her help

6. **What do you think about the idea of studying math in form of online games?**

    a. Cool

    b. I don't like it

    c. Um… it sounds impossible.

7. **Do you want to go to college?**

    a. Yes

    b. No

    c. Maybe

    d. It depends

8. **If you answer "No", "Maybe", or "It depends" to question 7, please explain below.**

    a. No one in my family has entered college

    b. Financial Issues

    c. I 'd rather find a job after graduating high school

    d. College is boring!

    e. My academic performance will not allow me to go to college

    f. I couldn't care less about college

9. **If you answer "Yes" to question, please explain**

    a. I think college is fun

    b. My family encourages me

    c. I have a role model who motivates me

    d. I want to be the first in my family to enter college

10. **What do you think about the lecture videos?**

    a. Too long, I fell asleep after 5 minutes.

    b. Too short, I wish it was longer.

    c. It is perfect. I like all of those lecture videos.

APPENDIX C: FIRST MATH SAMPLE TEST FOR DOHERTY MEMORIAL HIGH SCHOOL STUDENT

MCAS Sample Test

Materials

- Number Sense and Operations

- Patterns, Relations and Algebra

- Geometry

- Measurement

- Data Analysis Statistics and Probability

Section I: Multiple Choices

1. Which of the following is equivalent to expression below?

$$6 + 52$$

   a. $-(6 - 52)$
   b. $-(-6 - 52)$
   c. $-6 - 52$
   d. $-(-6 + 52)$
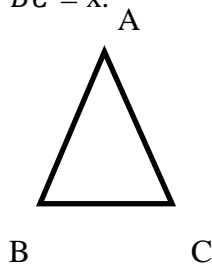
2. What are the solutions of x to this equation?

$$(2x + 5)(x - 2) = 0$$

   a. $\frac{5}{2}$ and -2
   b. $-\frac{5}{2}$ and -2
   c. $-\frac{5}{2}$ and 2
   d. $\frac{5}{2}$ and 2

3. What is the slope of the straight line that passes through points (0,1) and (3,7)?

    a. 2

    b. 3

    c. 4

    d. 5

4. A triangle and expressions representing the lengths, in centimeters, of its sides are shown below, $\overline{AB} = \overline{AC} = 2x$, and $\overline{BC} = x$.

Which of the following expressions represents the perimeter, in centimeter, of the triangle ABC?

    a. $5x$

    b. $4x^3$

    c. $4x^2$

    d. x^2

5. The table bellows show the number of pages, that Ivy read a book in five days.

Days	Number of pages
1	6
2	15
3	14
4	5
5	10

What are the median and average numbers of pages that Ivy read the book for a day?

    a. 15 and 7

    b. 15 and 8

    c. 10 and 9

    d. 10 and 10

6. The costs to build a table are shown below:

Labor	$20
Equipment	$30

What is the percent of the costs of labor to build a table?
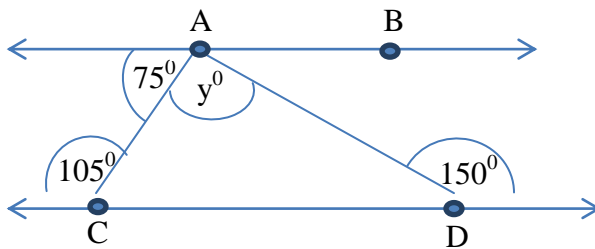
    a. 20%

    b. 30%

    c. 40%

    d. 50%

7. The first five number of a geometric sequence are shown below.

$$4, 12, 36, 108, 324, \ldots$$

What is the next number in the sequence?

    a. 972

    b. 402

    c. 249

    d. 3

8. In the diagram below, $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$. Find y

    a. 65

    b. 75

    c. 85

    d. 95

9. Based on the picture shown below, $\overline{AB} = 8$, in inches.
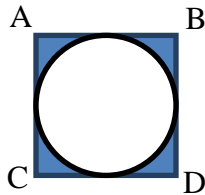
What is the area, in square inches, of the shade area?

    a. $16 - 8\pi$

    b. $16 - 16\pi$

    c. $64 - 16\pi$

    d. $64 - 16\pi$

10. Let $f(x) = -x + 10$, what is $f^{-1}(x)$?
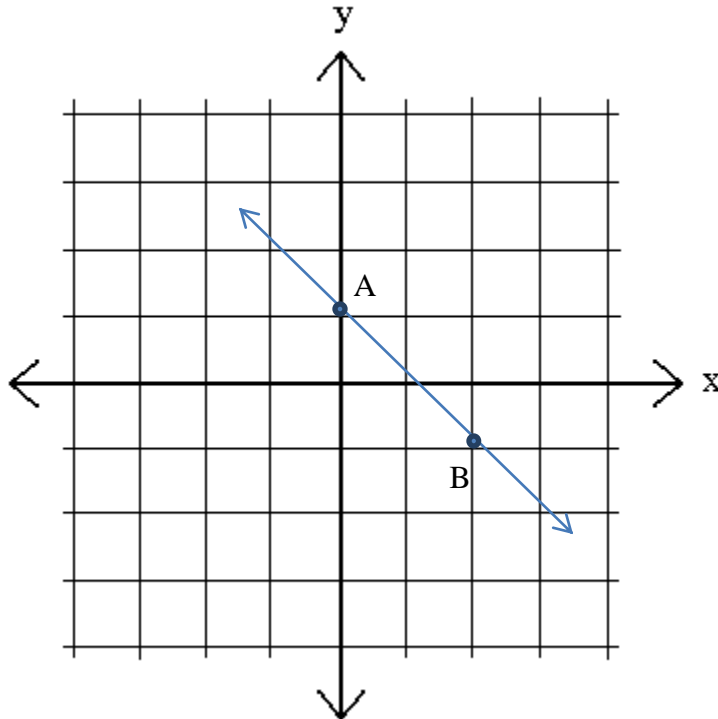
    a. $-x + 10$

    b. $x + 10$

    c. $x - 10$

    d. $-x - 10$

Section 2: For Question 11-15, write down the answer in the box.

11. What is the solution to $\dfrac{x}{5} - 3 + 7 = \dfrac{x}{10}$

    Answer $x =$

12. Based on the picture, what is the slope of $\overleftrightarrow{AB}$?

    Answer   Slope =

9

13. Find the area, in square inches, of the triangle ABC?
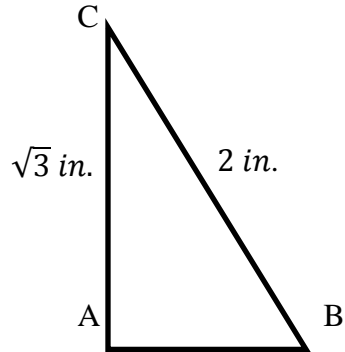
Answer:

14. Find the mode of the given data below.

1, 2, 3, 4, 2, 1, 3, 2, 4, 5

Answer   Mode =

Section III: Question 16-20, show your work.

15. Find the solution to the given equation.

$$(x - 5)(x^2 + 7x + 10) = 0$$

16. Simplify $-5 \cdot 2 + \frac{10 \cdot 5}{2} - 20 \cdot 10^0$.

17. Find the slope, and draw the graph of the given function:

$$f(x) = 2x + 5$$

APPENDIX D: SECOND MATH SAMPLE TEST FOR DOHERTY

MEMORIAL HIGH SCHOOL STUDENT

MCAS Sample Test (II)

Materials

- Number Sense and Operations

- Patterns, Relations and Algebra

- Geometry

- Measurement

- Data Analysis Statistics and Probability

Section I: Multiple Choices (1 point for each question)

18. What are the solutions of x to this equation?

$$(2x + 4)(x - 2) = 0$$

    a.   2 and -2

    b. − 4 and -2

    c.   2 and 2

    d.   4 and 2

19. Which of the following is equivalent to expression below?

$$6 + 52 - 20^0$$

    a. 38

    b. 57

    c. 58

    d. 88

20. What is the slope of the straight line that passes through points (1,3) and (3,9)?

    a. 2

    b. 3

    c. 4

    d. 5

21. A triangle and expressions representing the lengths, in centimeters, of its sides are shown

below, $\overline{AB} = \overline{AC}$ = x, and $\overline{BC}$ = x.
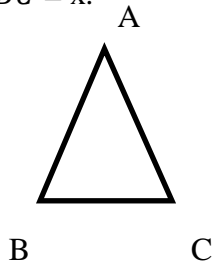
Which of the following expressions represents the perimeter, in centimeter, of the triangle

ABC?

    a. 3x

    b. 5x

    c. x^2

    d. $3x^2$

22. The table bellows show the number of pages, that Ivy read a book in five days.

Days	Number of pages
1	5
2	10
3	5
4	10
5	5

What are the median and average numbers of pages that Ivy read the book for a day?

    e. 5 and 5

    f. 5 and 7

    g. 10 and 5

    h. 10 and 7

23. The costs to build a table are shown below:

Labor	$2
Equipment	$3

What is the percent of the costs of equipment to build a table?

    e. 30%

    f. 40%

    g. 50%

    h. 60%

24. The first five number of a geometric sequence are shown below.

$$324, 108, 36, 12, 4,..$$
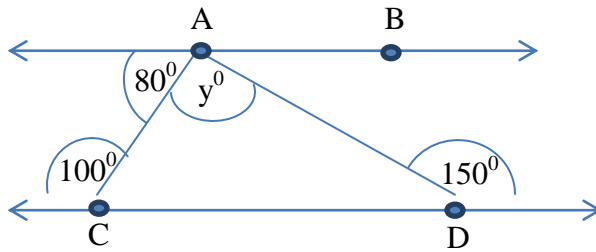
What is the next number in the sequence?

e. $\dfrac{4}{3}$

f. $1\dfrac{1}{2}$

g. 4

h. 3

25. In the diagram below, $\overleftrightarrow{AB}$ // $\overleftrightarrow{CD}$. Find y

a. 65

b. 70

c. 75

d. 80

26. Based on the picture shown below, $\overline{AB} = 8$, in inches.

A   B

C   D
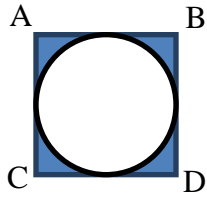
What is the area, in square inches, of the white circle?

    a. 8π

    b. 16π

    c. $16 - 16\pi$

    d. $64 - 16\pi$

27. Let $f(x) = -x + 10$, what is $f^{-1}(x)$?

    a. $-x + 10$

    b. $x + 10$

    c. $x - 10$

    d. $-x - 10$

Section 2: For Question 11-14, write down the answer in the box. (1 point to each)

28. What is the solution to $\dfrac{x}{5} + 2 = \dfrac{2x}{5}$

    Answer $x =$

29. Based on the picture, what is the slope of $\overleftrightarrow{AB}$?
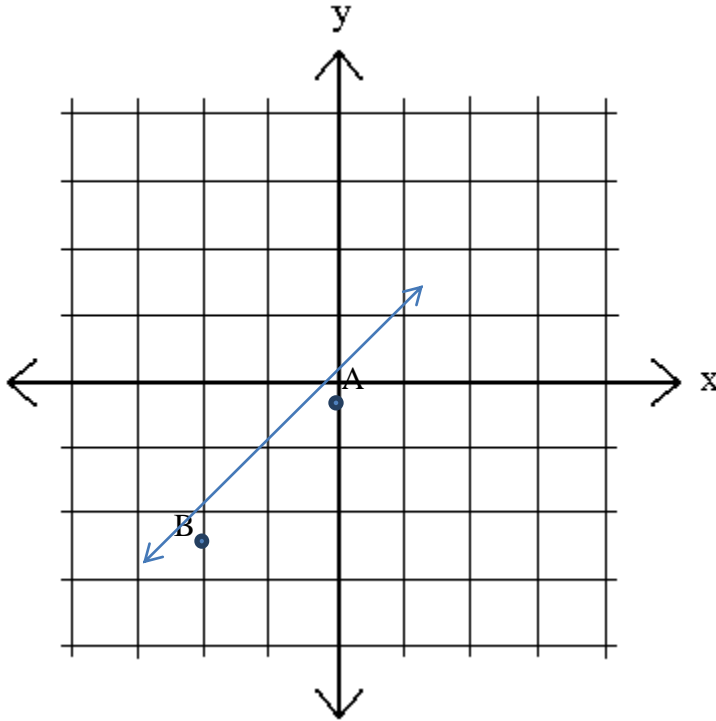
Answer   Slope =

30. Find the area, in square inches, of the triangle ABC?

Answer:

16
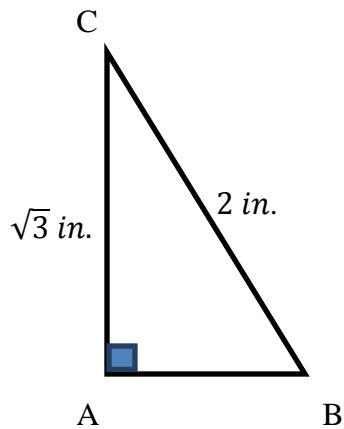
31. Find the mode of the given data below.

2, 5, 4, 9, 8, 2, 1, 4, 5, 4

Answer   Mode =

□

Section III: Question 15-17, show your work. (2 points for each question)

32. Find the solutions to the given equation. In other words, Find x.

$$(x^2 + 7x + 10) = 0$$

33. Simplify $5^0 \cdot 2^0 \cdot 10^2 - 20 \cdot 10^0$.

34. Find the slope, and draw the graph of the given function:

$$y = x + 3$$

APPENDIX E: REVIEW VIDEOS FROM KHAN'S ACADEMY

Below were the links of the review videos that students were assigned to watch.

1. Slope of Line
<http://www.khanacademy.org/video/slope-of-a-line?playlist=Algebra%20I%20Worked%20Examples>
Duration: 4:40 minutes
Related questions: 3, 12, and 17

2. Solving a quadratic by factoring
<http://www.khanacademy.org/video/solving-a-quadratic-by-factoring?playlist=Algebra>
Duration: 9:12 minutes
Related questions: 2 and 15

3. Function Inverse Example 1
<http://www.khanacademy.org/video/function-inverse-example-1?playlist=Algebra>
Duration: 6:44 minutes
Related question: 10

4. Pythagorean Theorem
<http://www.khanacademy.org/video/the-pythagorean-theorem?playlist=Geometry>
Duration: 10:46 minutes
Related question: 13

5. Area and Perimeter
<http://www.khanacademy.org/video/area-and-perimeter?playlist=Geometry>
Duration: 12:20 minutes
Related question: 9

Total times: about 45 minutes

APPENDIX F: MEETING AGENDA

1. IQP Meeting Notes: March 16, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

Agenda:
- Discuss about the IQP project
- Discuss about the potential high schools

Minutes (Meeting on March 9 2011)
- Discuss about the IQP's proposal.

Deliverables:
- Finalize meeting schedule

To-do-list:
- Tran writes the goal of the IQP and website.
- Nhan finds the hosting service website.
- Ngoc and Pat list out algebra topic.

2. IQP Meeting Notes: March 23, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen , Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Finalize timeline and milestone
- Revise the agenda to clarify each person's responsibility
- High-school commitment
- Discuss about applying game to our website
- Plan a meeting with Mr. Puma
- Discuss about interface/process of website construction
- Decide about presentation to advisor on Tuesday: who will present, take note, what will be discussed
- Type out the test based on MCAS test.
- Ask Professor's signature to change the IQP unit.

Minutes:
- Discuss about the IQP's goal
- Discuss about potential high schools

Deliverables:
- Find a high school (Doherty Memorial High School) for the test usability
- Write the IQP goal

To-do-list:
- Tran and Ngoc go to Doherty Memorial High School to ask for the MOU form and discuss about future plan for the test usability
- Nhan starts coding for the website
- Pat divides algebra topics into smaller sub-sections

3. IQP Meeting Notes: March 30, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Discuss about the meeting with Mr. Puma
- Go over the revised timeline
- Content of the interview/Survey: Khan's videos, questions, survey inputs…
- Format of the game/competition
- College Consultation Feature of the website
- Strage Innovation Award Application

Minutes (Meeting on March 23, 2011)
- Timeline for D-term and A-term. Parallel timeline for project progress and IQP writing.
- The format and content of survey/test & revise the letter of commitment/MOU

Deliverables:
- Obtained MOU from high school.
- Survey/Test Plan was specifically scheduled
- Obtain related videos from Khan's Academy for the test
- Primary research on competitors and game.

To-do-list:
- Decide the format of the games
- Nhan continues to build the basic of the website
- Tran, Ngoc/Pat go to DHS to administer the survey/test
- The whole team form the chart for competitor analysis
- Pat: analyze the data from survey inputs

4. IQP Meeting Notes: April 6, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

Agenda:
- Competitors Analysis. Set a clear standard of what aspect the writing focuses on
- Analyze the data from the test
- Format of the game/competition
- College Consultation Feature of the website
- Ask the professor to print out the 50 survey

Minutes (Meeting on March 27, 2011)
- Went over the revised timeline of D-term 2011 and A-term 2011
- Fill out the IRB form
- Discuss about grand and funding

Deliverables:
- Competitors Analysis lists
- First part of the test
- Filled IRB form

To-do-list:
- Tran writes the general business plan
- Pat and Nhan improve the interface of the website
- Ngoc uses dreamweaver to design the prototype for the game
- Pat organizes the videos topic wise and clearly state the related question to each video and sum up the time of the videos
- Tran starts writing the competitor analysis

5. IQP Meeting Notes: April 20, 2011

Attendees: Soussan Djamasbi (Faculty Advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

Agenda:
- Discuss about the comments from the judges
- Write email for Sponsorship
- IQP Writing

Minutes (Meeting on April 12, 2011)
- IRB Form
- More in-depth analysis of the first test
- Outline for IQP
- Start Writing Methodology

Deliverables:
- 1st Place in Strage Innovation Award

To-do-list:
- Finish data collecting for Proof-of-concept
- Write the second test sample
- Take PHRP course online

  (http://phrp.nihtraining.com/users/register.php?submit=Registration)
- Nhan: Meet Christine Drew to find good books/journals for Psychology behind

  Games/Competition.

6. IQP Meeting Notes: April 27, 2011

Attendees: Soussan Djamasbi (Faculty Advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Discuss about materials for second exam and survey
- Go over the IRB form

Minutes (Meeting on April 12, 2011)
- Discuss about the comments from the judges
- Write email for Sponsorship
- IQP Writing

Deliverables:
- Finish data collecting for Proof-of-Concept
- Write the second test sample
- Take PHRP course online

  (http://phrp.nihtraining.com/users/register.php?submit=Registration)

To-do-list:
- Give out the second exam and the survey to high school students
- Design logo and website functions
- Send the first draft to professor

7. IQP Meeting Notes: May 4, 2011

Attendees: Soussan Djamasbi (Faculty Advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Report the data analysis
- Discuss about the summer plan

Minutes (Meeting on April 12, 2011)
- Discuss about materials for second exam and survey
- Go over the IRB form

Deliverables:
- Give out the second exam and survey
- Analyze and compare data from first and second exam
- Generate rough design for the website

To-do-list:
- Recruit more tutors over the summer
- Improve website function
- Write business plan

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Discuss about the surveys

- Edit videos

Minutes (Meeting on May 6, 2011)
- Discussed about IQP meeting/tried to find an editor

- Uploaded videos

- Recruited more people to our website

- Discussed about writing a letter to Gate's foundation

- Discussed about funding

Deliverables:
- Videos

To-do-list:
- Upload videos

- Continue working on the data analysis/surveys

- Rewrite the first draft of IQP

- Recruit more people to visit the website

9. IQP Meeting Notes: September 8, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen, Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

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Agenda:
- Discuss about the surveys
- Discuss about the format of IQP writing
- Discuss about the milestone of the IQP
- Finalize timeline and milestone

Minutes (Meeting on May 6, 2011)
- Discussed about IQP meeting/tried to find an editor
- Uploaded videos
- Recruited more people to our website
- Discussed about writing a letter to Bill & Melinda Gates foundation
- Discussed about funding

Deliverables:
- Videos and lecture notes

To-do-list:
- Upload videos
- Continue working on the data analysis/surveys
- Rewrite the first draft of IQP
- Recruit more people to visit the website
- Schedule an appointment with the writing center

10. IQP Meeting Notes: September 30, 2011

Attendees: Soussan Djamasbi (faculty advisor), Tran Nguyen , Khanh-Nhan Nguyen, Patchara Santawisook, Ngoc Do

Agenda:
- Advertising Strategies

- Discuss about IQP Writing(continue)

- Discuss about website performance

Minutes:
- Discussed about IQP writing

- Advertised the website

- Edited the first draft

- Went to Boston to record fun videos

- Recruited more tutors to the website

Deliverables:
- IQP Writing

- Lecture Videos

- Advertising posters and fliers

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