Creating a Quality Online Math Course for TxVSN, Dual Credit, Collegiate: A Common Mathematical Educational Standard

A PROJECT in MATHEMATICS

by

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Abstract

In Texas high schools, students are being required to complete four years of high school math because of recent legislation (Texas Virtual School Network, 2009). This requirement will lead more high school students into a Pre-calculus course to fulfill their fourth year of mathematics. However, some students may take a Pre-calculus course and then take more advanced courses such as Calculus I the following year. At least, the new requirement for high school students will necessitate a higher demand for Pre-calculus teachers across Texas. Potentially this new State requirement will generate a greater need for online mathematics courses, such as Pre-calculus, than any previous time. The primary goal of this graduate project is to complete an online course creation guide as well as an online Pre-calculus course which satisfies multiple criteria: Texas Virtual School Network (TxVSN), Student Learning Outcomes (SLO's) for the course at an institution of higher education, as well as dual credit standards of learning (TEKS).
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Introduction

From 2003 to 2007, there has been a dramatic increase in the utilization of online course delivery to U.S. schools. Students in K-12 as well as higher education have participated in a dramatic increase in online course delivery (Stoltenkamp, Kies, & Njenga, 2007). There were 317,070 students enrolled in distance / online courses during the 2003/2004 school year. The following year, that number nearly doubled to 506,950 students (U.S. Department of Education, National Center for Education Statistics, 2008). The Texas Legislature has written into law under Senate Bill 1788 that Texas high school students will have the ability to take courses offered online to enhance their education in ways that would not otherwise be available (Texas Virtual School Network, 2009).

The Texas Education Agency has named the official online learning community the Texas Virtual School Network or TxVSN. Through the TxVSN, any public, private, charter school district or College/University may opt to become a provider district. The receiver districts may only be public, private, or charter school districts which serve grades K-12 (Texas Virtual School Network, 2009). The State of Texas is currently making efforts to build its inventory of online delivered courses as well as instructors who have been certified to teach through this network. Currently, there are many courses available for students to enroll in, including mathematic courses from Algebra I to Calculus I. Presently, there is only one Pre-calculus courses offered through the TxVSN online course catalog as regular high school credit. The goal of this project is primarily to articulate a concise, but complete, manual for creating online courses that meet
the TxVSN acceptable guidelines as well as all collegiate learning outcomes. In essence, this project will not only describe but in fact model the steps of developing a quality online course through the creation of an online mathematics course.
Related Works and Literature Review

The growing trend for institutions to expand their online course offerings is due to several factors. Approximately 93% of the colleges surveyed cited access as the primary reason for offering courses online (Allen & Seaman, 2007). Online learning provides access to those students who may have a scheduling conflict due to another class, work, or childcare issues. By allowing all students the option to participate in an online learning community, some students may take more courses because of the scheduling flexibility (Allen & Seaman, 2007). The patterns of increased enrollments of online courses have been substantially higher than increases in face-to-face enrollments. The pattern is expected to continue for the foreseeable future (Allen & Seaman, 2007).

The virtual online community is a growing trend both in institutions and at the K-12 learning levels. The increase in online courses being delivered at the secondary levels may increase the demand for online courses as these students enter into colleges. “Colleges saw a 17 percent increase in online enrollment, with more than one in four students taking at least one online course in the fall of 2008, according to the findings of an annual survey published on Tuesday by the Sloan Consortium (Allen & Seaman, 2009, p.1)”.

Institutions which want to capitalize on this growing trend in education will need to begin to develop an immediate plan to add or modify their course structure (Bennett & Lockyer, 2004). It is also imperative to assure the quality of the online learning environment is consistent with national and state online learning standards while keeping the rigor of the institution.
Most leaders of institutions believe the demand for online courses is still increasing while virtually every institution questioned who offers online courses expect enrollments for those courses to increase (Allen & Seaman, 2007). In addition to institutions, many states have already begun building virtual school networks for grade levels K-12 (Clark, 2000). The primary reason for creating virtual school networks is to provide equal access to the rigorous, well designed online courses (Fast Facts About Online Courses, 2007). For example, some smaller high schools may be limited in the course offerings when it comes to electives, foreign languages, or even higher level courses which can be offered. However, larger high schools have more resources and therefore can provide a larger selection of courses to their students. By making a vast variety of courses available online to every high school student through the TxVSN, students from all areas can now have access to study a course which may not be available within their own school or district.

In addition to equal access, research from the North American Council for Online Learning (2006) cites the strengthening of students' 21st Century skills as being another very important goal for the online learning environments. The 21st Century skills are concerned with technology understanding and proficiency, or the kind of technology skills students will be expected to know when entering the workforce upon high school or college graduation.

The North American Council for Online Learning (2006) states:

Online learning through virtual schools is one of the most important advancements transforming education in the U.S. It is imperative that 21st
Century skills be incorporated into the design, delivery and implementation of virtual schools. By expanding access to high quality, rigorous academic courses teaching 21st Century skills, we can expand the opportunities for all students. (p. 9)

The online courses should require students to utilize, develop, and master 21st Century skills. The integration of 21st Century skills should be threaded within online courses (Silva, 2008). This will help the students be ready for the work environment when they graduate. 21st Century skills are sorted into the following categories: content, learning and thinking skills, information and communication technology, and life skills. (North American Council for Online Learning and the Partnership for 21st Century Skills, 2006). The frequent requirement to perform 21st Century skills by utilizing creativity, innovation, resource management, global awareness in addition to different types of communication technologies as they progress through the online course will better prepare students for entrance into the workforce.

Texas has set up a virtual online learning environment and it is named Texas Virtual School Network (TxVSN). TxVSN is still building its catalog of high quality online courses. Currently, the TxVSN only has courses available for secondary students (Texas Virtual School Network, 2009). The Texas Education Agency provides stipends for those educational facilities who participate as a provider or receiver district. Both provider and receiver districts have a financial incentive to participate in the TxVSN online learning community. Each type of participant has required avenues and procedures to participate in their desired
capacity. Additionally, each type of participant has a vested interest in the success of the student who takes the approved TxVSN online course.

Research has shown that certain design strategies for online courses will engage students in different ways (Allen & Seaman, 2007). To maintain the integrity of online mathematics courses, the level of rigor, assessment, coverage of appropriate standards/objectives, communication, and instructional design components must be readily adhered to the corresponding traditional classroom face-to-face course (North American Council for Online Learning and the Partnership for 21st Century Skills, 2006). For this reason, the online mathematics course being developed as part of this project should be designed and created by a mathematician who has either online or face-to-face experience in the mathematics course being developed. When developing the online mathematics course, it was necessary to provide adequate scaffolding, resources, and explanation, all of which could not be provided by a person without the mathematical background or relevant mathematical teaching experience.

In addition, the design of online courses must incorporate intuitive design principles for delivery of the online course. “Poor quality in Web design can frustrate learners and hinder their progress” (Chao, Saj, & Tessier, 2006). To create ample opportunity for all students, the course design should be easy to navigate throughout the entire course. Overall appearance and correct grammar, spelling, and presentation (color, layout, and font sizes) are vital components that can either pronounce or diminish all other aspects of an online course (Chao,
Saj, & Tessier, 2006). In summary, the virtual design must be simple, consistent, and accommodating for different learning styles. The distribution of the course should be in a flexible format and must contain a variety of instructional materials in order to reach all learner styles.

Lastly, online courses inherently need communication features incorporated as part of the course (National Standards of Quality for Online Courses, 2007). Primarily, the students and instructor need to have avenues to communicate and share ideas, questions and comments. Some types of communication must remain private, one-to-one, while others may be implemented in a forum or discussion board. There are two main types of online communications: asynchronous and synchronous. It is critically necessary for an online course to exhibit both types of communication within the online course. Each type of communication has its own purpose and developmental impact for the online student. "Asynchronous e-learning, commonly facilitated by media such as e-mail and discussion boards, supports work relations among learners and with teachers, even when participants cannot be online at the same time" (Hrastinski, 2008, p. 52). Asynchronous communication provides the opportunity for the online students to provide input according to their own schedule and after they have had sufficient time to reflect and analyze the topic. This type of interaction appeals to many users because they do not feel "rushed" or "surprised" as if they were picked to ask a question in a face-to-face classroom (Hrastinski, 2008).
On the other hand, synchronous communication helps students interact in a 'live' setting (Hrastinski, 2008). These types of communication are usually implemented through video chat programs or similar presentation software such as Elluminate (Wootton, 2009). This kind of communication has been related to the social development and sense of community of the online student. The feeling of being part of a greater group helps build that social connection to help the students connect to each other as well as the instructor (Hrastinski, 2008). It is also a means to get direct answers to questions in a direct and quick manner. In synchronous communication, the instructor may poll the users and receive immediate feedback which will allow for modification of the lesson or additional support if the topic appears to be overbearing. Synchronous communication helps alleviate some of the anxiety for students when learning new topics (Hrastinski, 2008). The combination of asynchronous and synchronous communication activities built into an online course helps online students feel like they are part of a class instead of isolated (Hrastinski, 2008). In addition, the online course begins to feel more similar to a face-to-face class setting by being able to interact with other classmates or the instructor in a live setting. Thus, the students have all of the convenience of being at home and have frequent online interactions which build their sense of community. An online instructor may also get to know the students better by providing a variety of asynchronous and synchronous activities with the online course.

Throughout the review of much material relating to online teaching and the construction of online courses, there have been many references to enumerate
exactly what constitutes a quality online course. Invariably, some experts in
online education have unique opinions as to specificities of which must be
contained within a quality online course. However, the vast majority will agree
more often than disagree on the components necessary to construct a quality
online course. With the (International Association for K-12 Online Learning
standards (iNACOL) as a baseline, the author created the guiding principles for
the construction of a quality online course.
Methodology

Due to the nature of an increased demand for online courses, this manuscript serves as a guide created to assist and inform educators when developing an online course. By adhering to all of the guidelines discussed in this guide, the integrity and quality of the online course will be produced. We will present a set of guiding principles to provide a structure for course instructors at all educational levels a meaningful tool to help facilitate the development of highly engaging online courses. In particular, the online mathematics course which is derived from these principles will serve as a model that satisfies the criteria for a quality online course as described with the guiding principles of this project.

While deciding on which course to develop, a variety of information and sources influenced the decision to propose Pre-calculus as the online course for this project. First, there is a greater population of potential students which could utilize Pre-calculus as a course to be taken online. Potentially, high school and college students may wish to take this course online to suffice their academic requirements. Secondly, there are a deficient number of Pre-calculus courses for both face-to-face and online courses at all levels of education. This course could assist a greater population of students because of greater need across the state of Texas. Lastly, the TxVSN online library has only one other Pre-calculus course currently being offered through their online library of approved courses for state credit. If approved by TxVSN, this Pre-calculus course could provide dual and/or
high school credit to Texas high school students who successfully complete this course.

Therefore, the online mathematics course developed as part of this project is in alignment with Texas high school (TEKS) learning objectives (appendix 2) for Pre-calculus as well as the learning objectives for a Pre-calculus course at an institution of higher education in Texas (appendix 1). Additionally, the developed course is sufficient to satisfy the criteria for quality online delivered courses as outlined in the TxVSN criteria. In maintaining both standards, this course may satisfy the requirements for Dual Credit if taken and completed by a Texas high school student.

In grades K-12, students will be exposed to mathematic courses including a minimum of 1 year of the following courses for the recommended graduation plan: Euclidean Geometry, Algebra I, and Algebra II (House Bill 3, 2009). In some cases, students may complete mathematics up to Calculus BC (Integral Calculus). In each course, the previous course helps prepare the student with the necessary skill set required to perform the required task in the next sequential course. The Texas TEKS outlines the required learning objectives for each high school course taught as well as the pre-requisites for all high school courses (Texas Education Code 111.31). In Texas high schools up until the early 1990’s, the highest mathematics course taught was Differential Calculus. Students, who wished to take this course would take one semester of Analytic Geometry and one semester of Trigonometry as pre requisites for the Differential Calculus to be taken the following year. As more Texas high school students began taking
Differential Calculus, TEA added an additional course named Pre-calculus. In September 1998, the Texas Education Agency developed and created TEKS for the high school mathematics course known as Pre-calculus which combines the necessary learning objectives and the foundational mathematic skills necessary for students to succeed in the first two semesters of Calculus (AB & BC).

Since this course is designed to meet criteria for both a Pre-calculus course a student would take at a Texas high school and an institution of higher education, we must compare both of them. When comparing the learning objectives from an institution of higher education (see appendix 1) and a Texas high school (see appendix 2), the vast majority of learning objectives are the same, or at least very similar. In both high school and institutions of higher education, the goal of Pre-calculus is to serve as a transition course between concepts relying on Algebraic mathematics and principles of Trigonometry and Calculus. The differences observed by the author rest primarily in the manner in which the course material is delivered to the student.

In high school, Pre-calculus is most commonly taught in two semesters. This allows the high school teacher to present the concepts in greater detail than if the course was contained in a single semester. In an institution of higher education, Pre-calculus is taught in a single semester. The Texas high school student will meet every day for about 1 hour. The student at an institution of higher education will usually meet 3 hours per week in either a 2 or 3 day per week meeting arrangement. While these may seem like minor differences, the differing instruction models may have effects on student's ability to grasp the
concept. To some extent, smaller segments of learning may prove to be a more equitable learning strategy than the block model of an institution of higher education.

Students may enter a university with varying mathematical skill sets based on their personal or geographic background. Because of this challenge, students may need to refresh or build their mathematical skill set prior to attempting Calculus I at the collegiate level. Most institutions offer College Algebra, Trigonometry, and Pre-calculus as preparatory courses to Calculus I. At institutions of higher education, there are common components between these three courses, however the Pre-calculus provides sufficient student learning outcomes to provide an adequate array of skill sets required to understand and learn Calculus I and subsequently higher degrees of mathematics. Although some students may wish to take College Algebra and or Trigonometry before taking Pre-calculus, students with a solid algebraic foundation may shorten their coursework by taking Pre-calculus as the only mandatory pre-requisite course to Calculus I.

Pre-calculus in an online environment provides several distinct advantages over either face-to-face format. For example, a student enrolled in an online Pre-calculus course can study specific topics until they have mastered it, and then continue at their own pace forward through the next topic. In face-to-face courses, students can’t control the rate of delivery of the professor. This sometimes adds confusion to a student who may already be struggling in one or more prior mathematical concepts.
Typically, students in this online Pre-calculus course are introduced to one section with a focused mathematical concept. Each chapter maintains the same cycle of introduction of topic with a variety of instructional material, practice, and mini-assessment through each section with a chapter assessment at the conclusion of all sections within a chapter. The student would review the power point slides, lecture notes, guided practice videos for the section to be covered. Once the student has reviewed these instructional materials on this section, they would attempt corresponding practice homework in the MyMathLab component of the content provided by the publisher. MyMathLab is an electronic component provided by the book publisher Pearson used to accompany the LMS content. Students may prefer this layout better than a traditional presentation offered in face-to-face courses, because it separates the topics and sub-topics along with the supporting materials which allow them to easily target their weakest mathematical skills and spend the appropriate amount of time to improve them without having additional material.

This process consists of access to publisher created content, practice, homework assignment, assessments, and tutorials which a student can access through the internet as part of the students enrollment in any math course that uses this component. If a student has problems while in the practice homework, they may get computer aided assistance and prompts to assist in the completion of the problem without feeling rushed or confused by additional material. After completing the problem, students may choose to continue working on a similar problem until they have mastered that particular concept. If additional help is
required, students may review a host of guided video lessons to help clarify
details on how to solve that type of mathematical problem. The time restraints in
a face-to-face course do not apply in the online Pre-calculus course created as
part of this project. The student can progress through the material at their own
pace which is dependent solely on their own understanding of the material. Once
a student feels comfortable with this section of material, they may attempt the
graded online homework, which is in-effect a mini-assessment. The student is
then ready to continue to the next section of the chapter in the same manner until
all of the sections in that chapter are completed. Once all of the sections have
been completed, the student may then attempt the chapter test, which is a
chapter assessment.

Students comfortable with the topics covered, can move through the
comprehended material quickly. On the contrary, students who become stuck
can repeatedly practice the challenging material until they have mastered it.
Most online learning management systems allow for this type of repeat practice
in mathematics by utilizing rule based algorithms which basically use the exact
same type of problem but with different numbers.

During the course of literature review for this project, a common thread
appeared through the volumes of information derived and collected since the
conception of online learning many years ago. The commonalities with a variety
of noted sources remained well supported and in fact necessary for the creator of
an online course to consider. Through a process of integrating, culling, and
combining topics which were addressed by the totality of sources reviewed, a
well considered set of guiding principles have been created and generalized into 3 basic categories. Furthermore, specific components for each of the 3 basic categories were included to sufficient specificity to help an educator who is in the process to build a quality online course.

The guiding principles for this project are as follows:

1) An online mathematics course should contain the following components equal to its equivalent face-to-face course.
   a. a level of math rigor,
   b. assessment,
   c. coverage of the appropriate standards or learning objectives,
   d. communication of information and policies,
   e. instructional design.

2) An online mathematics course should contain the following online aspects implemented in the online structure and delivery of online material.
   a. Incorporate an intuitive navigation model which is uniform throughout the online mathematics course,
   b. Distribution of course content in flexible format along with a variety of presentations of instructional material,
   c. Use of the 21st Century skills as needed and used in the present work environment.

3) An online mathematics course should have at least two interactive components as well as activities which help the student develop a strong
sense of community. The interactive components may be any combination of the following types (at least one of each type):

a. Asynchronous,
b. Synchronous.

H. Jung's template divides the process of online teaching into 3 phases listed below. This guide focuses primarily on phase 1 and phase 2. According to H. Jung's Online Course Template Guide (Jung, 2011), there are three basic phases to creating an online course.

- Phase 1- Building your Online Course Framework.
- Phase 2- Working with your Designer and Enhancing your Course.
- Phase 3- How to Manage your Online Course and Communicate with your Students.

Phase 1 includes specific information to the instructor and course which is not content based. It includes items such as names of the instructor, section numbers, syllabus, contact information, office hours, and other files necessary but not considered content related.

Phase 2 includes content based information. The content may be produced by the professor or by a third party such as an author of a book and/or publishing company. The trend for publishers is leaning toward online content including online text to accompany the online content which has been professionally created to assist instructors who adopt their text book for use in their courses. During this phase, the professor would work with an instructional
designer (if available) to improve or add features to the online course to improve accessibility, intuitiveness, and additional features as necessary. The technical support for the particular learning management system may also prove to be a useful resource for this area of course creation process. Phase 3 would be the phase where the instructor would learn how to effectively communicate with their students using the learning management system (LMS) and how to make changes in the online course as necessary. The LMS is a computer software program which is used to help manage and deliver online coursework. At the completion of this phase, the course is ready for enrollment and should only require minor changes from one year to the next.

Teaching in an online environment is substantially different than teaching in a face-to-face environment. To be an effective online instructor, the instructor must first feel comfortable with the technology. Having obtained a M.S. in Computer Science the author feels like technology is a part of his inner self. So, naturally, teaching with technology is also a comfortable environment for the author. The author has been trained to teach in the traditional classroom environment and has also completed TxVSN training which is geared towards the online teaching environment. Additionally, the author has obtained training and certification to be a reviewer for TxVSN mathematics courses. Having the experience of reviewing and critiquing a myriad of online courses serves the author with invaluable experience which could not be replaced by any other activity. Finally, the author has taught a variety of online mathematics courses including, College Algebra, Pre-calculus, and Calculus, over the past 4 years.
During the past year, the author worked on the various stages of this project to ensure that a quality product is disseminated upon completion. In various projects the author has been involved in, the cycle of revision seems to continue indefinitely. Though the timeline on the next page does not mention revision, there has been a sufficient occurrence of revision to many aspects of the project. The primary purpose for the timeline was to set milestones in the project. As most people who have worked on sizeable projects have discovered, it is critical to work on specific parts of the project until it is completed. The timeline helped the author facilitate this type of strategy and also helped him see if the project was ahead or behind of schedule.
Timeline

September 2010  Literature review and proposal outline
November 2010  Write, edit and revise proposal
December 2010  Defend proposal
January 2011  Write Online Course Creation Guide & Create Online Mathematics Course which integrates TxVSN Learning Strategies with TAMU-CC Learning Outcomes
April 2011  Complete customized Online Course Creation Guide
April 2011  Complete Online Mathematics Course
July 2011  Final revisions of the project and submission of the final draft manuscript to committee
August 2011  Defend project
Results

This project, including the online course creation guide within, has been used to create a quality online Pre-calculus course. All online courses must address content, delivery, and engagement. By utilizing the online course creation guide to construct a Pre-calculus course, all essential components of a quality online course have been addressed sufficiently. The challenge was not to create an online Pre-calculus course, but to create a quality online Pre-calculus course which satisfied a multiple set of standards. Namely the TxVSN, SLO’s of an institution of higher education, and dual credit (TEKS).

Unlike many other disciplines, mathematics requires the recall and application of skill sets learned in previous mathematics courses. For Pre-calculus, the learner must recall and apply skills he or she may have learned in courses such as Algebra I, Algebra II, or Euclidean Geometry. In mathematics, each course taught builds on many elements of the pre-requisite course. During the Pre-calculus course designed for this project, it is necessary to assist students in developing problems solving skills as well as learning specific computational skills. The course is imbedded with underlying learning techniques mentioned in Mark Driscoll’s (1998) book *Fostering Algebraic Thinking: A guide for Teachers Grades 6-12*. Without the ability to not only understand the topics in Pre-calculus, but understand methods used to scaffold and explain the concepts in a clear concise delivery, the construction and design for an online Pre-calculus course would likely be unsuccessful. The careful blend of new content on one hand, and spiraling old content on the other hand, is essential in Pre-calculus.
In the online Pre-calculus course designed for this project using the online course creation guide, the content has been organized and included to help the student be successful in Pre-Calculus. According to Driscoll (1999), the types of learning mentioned are: “doing and undoing, abstracting from reason and building rules to represent functions” (p. 8). Throughout the course, all three of these learning methods are utilized throughout the exercises in the course.

The first chapter in the online Pre-calculus course is a review chapter. Chapter 1 helps spiral important concepts from prior learning such as the distance and midpoint formulas, equations of more than one variable with graphing and intercepts, and a review of lines and circles. These concepts are likely covered in other foundational courses such as Algebra I and Algebra II; however these concepts are reviewed to provide an adequate foundation for all students. Chapter 2 begins with simple graphs of functions and quickly moves to piecewise functions, transformations of functions, and building of functions. Linear and quadratic functions are covered in chapter 4 while exponential and logarithmic functions are explored and extended in chapter 5. So a good portion of the first 5 chapters contains review of prior learned concepts and extensions of those concepts. I have placed a midterm exam covering chapter 1 through 5 at this point. The remainder of the course relies on a student’s proficiency in chapters 1 through 5; however the vast majority of chapters 6 through 12 are unexplored territory. Trigonometry is introduced for the first time in chapter 6 and Analytic Geometry in chapter 7. The next 2 covered chapters’ help students utilize their skills reviewed and learned in the course up to this point with
"Applications of Trigonometry" and "Applications of Analytic Geometry". Next, students learn 3 distinct methods to solve systems of linear equations and inequalities. This topic, as well as sequences and probability, is extended past the coverage of high school Algebra II students’ expectations, but it is introduced as if there is not any prior knowledge in these topics. The last chapter in this course is an introduction into Calculus principles such as finding limits using tables/graphs, algebraic methods, and one sided limits of continuous functions. Essentially, this course covers the necessary mathematical concepts and prepares a student for the algebraic and trigonometric skills required in Calculus I & II.

Many other introductory subjects seldom reach past the comprehension level of Blooms Taxonomy. In Pre-calculus, especially online Pre-calculus, it is vital to provide sufficient practice and variance for each application of the principles being taught for future studies. It is also necessary when instructing students to provide a process to solve problems. Especially in Pre-calculus which often requires the student to evaluate, synthesize, and analyze problems in order to demonstrate mastery of the topic being studied. As in face-to-face courses, the ability for an instructor to help students develop the skills mentioned above to solve complicated problems is a task requiring much preparation and forethought. In this online Pre-calculus course, the instructor utilizes multiple representations to assist students to develop and culture the problem solving process. The multiple representations most often used are function notation, concrete examples, graphical illustrations, and tabular data which are all
representations of the same problem. In order for a course creator to be in a position to assist students in accomplishing this task in Pre-calculus, the instructor and/or online course creator must have sufficient understanding of the SLO’s and TEKS to be addressed during the coursework. Furthermore, to create, design, supplement, and authenticate an online Pre-calculus course, the instructor must exhibit proficiency of the topics covered within the course.

It is necessary to mention the process of developing an online course. Invariably, there are countless pathways to developing a quality online course. For some creators, every aspect and component must be created from print outs. Others may opt for the professionally developed content packages for their specific course and make alterations to fit their own criteria. Additionally, each online course developer will need to choose which Learning Management System (LMS) they will utilize. For the proposed Pre-calculus course, the author has chosen to utilize Pre-calculus content written by Michael Sullivan from Pearson Publishing. This content offered an electronic copy of the book as well as a printed Lab Version of the text book which is intended for students to use in an online environment. This content had many excellent features including the ability to customize almost every component of the content package. Once the content package was selected, the shell of the course was ready to be customized. The Pre-calculus content shell did include many multimedia components such as guided instructional videos, videos connecting topics to real life scenarios, and the ability to add discussion board topics, announcements, or additional content as necessary. The guided instructional videos provide a
source for direct instruction on the topics in each section of the content. As the
instructor, the author provides support and additional explanations in addition to
assistance finding appropriate support material within the course.

Once the content is created or generated, the next step in the project is to
verify all of the Student Learning Outcomes are covered and decide what, if any,
parts of the course are to be modified, removed, or added. As in face-to-face
courses at institutions of higher education, this is not a matter of covering every
section of the given textbook, the same challenge applies to online course
creation. It was necessary to verify the correlation of the SLO’s and the
 corresponding math content in the online course were taught. After verifying that
all essential SLO’s were addressed, the author then enriched the course by
adding additional elements to the course. Even though the Pearson created
content had volumes of material, the author added mini-lecture notes & power
point slides for every covered section to provide a different learning paths and/or
written notes for the students (Texas Virtual School Network, 2009). Discussion
board threads were added to engage students in learning, virtual online meetings
to connect and collaborate between students and the instructor, in addition to
custom generated homework assignments, quizzes and exams. The assessment
components were constructed using rule based algorithms, created by a tool
entitled TestGen which is provided by the publisher of the online content, to help
maintain the integrity of the exercise in the event that two or more students were
working on the same exercise at the same time. The integrity of the exercise
would at the very least maintain the separate unique problems between the
students exercises. In contrast, some courses may choose to have a set number of problems which would likely allow the same problems to repeat often between students taking that particular assignment. I prefer the first method because of concept of new problems versus recycled problems.

At routine intervals in the course, it is imperative to have both asynchronous and synchronous dialog. Without the routine communication, students may feel disjointed to the online class and may lose interest in the course. Without the connectivity, the course starts to look more like a correspondence course that has been uploaded to a website. To fulfill this requirement the author would connect with the students utilizing discussion boards, live meeting software (Elluminate), email (both individual and group), and online course announcements. The challenge to having students feel connected in a virtual environment is partially accomplished by creating meaningful aspects to the items mentioned earlier. For example, when creating a discussion board thread, it is necessary to require the students to participate. This must be part of the students' grade for them to have a stake in actively posting on the discussion board. Additionally, discussion prompts should most often be tied to the content. At the beginning of a course, it is advisable to post a discussion board topic such as “Introduction – Introduce yourself to the class and reply to at least 3 other students' postings.” The author would suggest about one discussion board exercise per week. For week two, the topic for the discussion board was “Please share with the group any challenges with the online learning class that you experienced and post a reply to at least 2 of your classmates’ postings.” For the
majority of the remaining weeks, the discussion board threads were something of the nature “List the easiest and hardest type of problems in this chapter” or “Please post one problem – and find at least one alternate method to solve 2 other students’ problems”. Please see the image below:

![Discussion Board]

- Visit Instruction Orientation
- Graded Homework, Quizzes, and Exams
- Introduction – Introduce yourself to the class and reply to at least 3 other students’ postings.
- Challenges - Please share with the group any challenges with the online learning class that you experienced and post a reply to at least 2 of your classmates’ postings.
- Chapter 1 & 2 - Easiest and Hardest Problem
- Best method to learn a problem in Chapters 3 & 4
- Midterm - Fair or Not Fair
- Chapter 6, 7, & 8 - Favorite Problems
- Chapters 10, 11, 12, & 13
- Final Exam - Glad it is over or Wish I could do it again

In the instances when the author utilized the *Elluminate* software program for live chat sessions, the students asked more questions and gave more indications of participation than in face-to-face lectures. The students reported in emails that they liked the live meeting tool and were excited about the ability to ask questions in a "live" setting but not have to physically attend a classroom. There are many tools which are similar to *Elluminate* and will accomplish the task of "live meetings" with the students. The biggest challenge the author faced, was finding the best time for students to meet. To that end, the author utilized an online survey tool (not part of the LMS) to produce a questionnaire about meeting times in order to accomplish this task most efficiently. The process of
customizing the online course prior to delivery is of considerable importance to insure the online course is meeting the necessary components to achieve a preponderance of the goals to satisfy the threshold of a quality online course as discussed in the online course creation guide.

Lastly, the online course must be maintained and modified from semester to semester to assure all the updated SLO’s are still being adequately covered and properly discussed within the course. Information, such as office hours, syllabus, contact information, course instructor may change from the previous semester and should reflect the current information at all times. Additionally, the course must maintain a dynamic appearance to help the students connect and engage in the online course as the semester unfolds. As new semesters are beginning, old post and announcements should be removed and new pertinent information should be posted. If there are announcements from a previous semester which are relevant to the current semester’s students, then the date should be refreshed from the control panel menu.

The online course creation guide was used to develop the online Pre-calculus course, while referring to the guiding principles of the guide. In order to produce the highest quality online course, the recommendations as well as additional standards referenced within the guide were deeply considered and integrated within the course. The Pre-calculus course, which is a product of the online course creation guide, adequately utilized the principles of the online course creation guide. Additionally, the designed Pre-calculus course sufficiently illustrates every essential aspect that determines if an online course is
considered engaging and interactive in relation to International Association for K-12 Online Learning (iNACOL) standards.
Summary of Project

The outcome of this research project is a combination of two products. The author has developed this document as an online course creation guide as well as a single well developed web course (Pre-calculus) which will fulfill multiple sets of criteria, namely the TxVSN and the learning outcomes and requirements from an institution of higher education in South Texas. The online course creation guide not only provides a detailed set of instructions necessary to create a well developed online course that meets the requirements for TxVSN requirements, but is also a helpful tool for any creator of an online delivered course. The online course creation guide utilizes summary reports of existing online standards and best practices in addition to helpful hints and detailed explanations whenever needed.

The second product of this project is an online mathematics course which may also become a course offered by an institution of higher education as an online course for current/future college students and/or high school students. The actual mathematics course created may directly benefit Texas students who are enrolled in a Texas public, private, or charter high school as well as students at an institution of higher education. The development of this online course will be used to illustrate best practices in addition to the essential components of an online course.
References


The Texas Virtual School Network. (2009). TXVSNFAQ. 
http://www.TxVSN.org/TxVSNFAQ.aspx

The provisions of this §111.31 adopted to be effective September 1, 1996, 21 TexReg 7371; amended to be effective August 1, 2006, 30 TexReg 4479.


Appendix 1 - Texas A&M – Corpus Christi Student Learning Outcomes

• SLO1. Analyze and synthesize information concerning real-life data
Organize data, communicate the essential features of the data, and
interpret the data in a meaningful way;
  o Extract correct information from tables and common graphical
displays, such as line graphs, scatter plots, histograms, and
frequency tables;
  o Express the relationships illustrated in graphical displays and tables
clearly and correctly in words and/or use appropriate technology to
describe and analyze quantitative problems (median-median line,
least square line, etc)

• SLO2. Analyze and synthesize information concerning attributes of
functions, relations, and their graphs.
  o Understands when a relation is a function.
  o Identifies the mathematical domain and range of functions and
relations and determines reasonable domains for given situations.
  o Understands that a function represents a dependence of one
quantity on another and can be represented in a variety of ways
(e.g., concrete models, tables, graphs, diagrams, verbal
descriptions, symbols).
  o Identifies and analyzes even and odd functions, one-to-one
functions, inverse functions, and their graphs.
  o Applies basic transformations to a parent function, f, and describes
the effects on the graph of y = f(x).
  o Performs operations (e.g., sum, difference, composition) on
functions, finds inverse relations, and describes results symbolically
and graphically.

• SLO3. Analyze and synthesize information concerning linear and
quadratic
functions and use them to model and solve problems.
- Understands the concept of slope as a rate of change and interprets the meaning of slope and intercept in a variety of situations.

- Writes equations of lines given various characteristics (e.g., two points, a point and slope, slope and y-intercept).

- Applies techniques of linear and matrix algebra to represent and solve problems involving linear systems.

- Analyzes the zeros (real and complex) of quadratic functions.

- Makes connections between the $y = ax^2 + bx + c$ and the $y = a(x - h)^2 + k$ representations of a quadratic function and its graph.

- Solves problems involving quadratic functions using a variety of methods (e.g., factoring, completing the square, using the quadratic formula, using a graphing calculator).

- Models and solves problems involving linear and quadratic equations and inequalities using a variety of methods, including technology.

- SLO4. Analyze and synthesize information concerning exponential and logarithmic functions and use them to model and solve problems.

  - Recognizes and translates among various representations (e.g., written, numerical, tabular, graphical, algebraic) of exponential and logarithmic functions.

  - Recognizes and uses connections among significant characteristics (e.g., intercepts, asymptotes) of a function involving exponential or logarithmic expressions, the graph of the function, and the function's symbolic representation.

  - Understands the relationship between exponential and logarithmic functions and uses the laws and properties of exponents and logarithms to simplify expressions and solve problems.

  - Uses a variety of representations and techniques (e.g., numerical methods, tables, graphs, analytic techniques, graphing calculators)
to solve equations, inequalities, and systems involving exponential and logarithmic functions.

- Models and solves problems involving exponential growth and decay.
- Uses logarithmic scales (e.g., Richter, decibel) to describe phenomena and solve problems.
- Uses exponential and logarithmic functions to model and solve problems involving the mathematics of finance (e.g., compound interest).
- Uses the exponential function to model situations and solve problems in which the rate of change of a quantity is proportional to the current amount of the quantity [i.e., \( f'(x) = k f(x) \)].

- SLO5. Analyze and synthesize information concerning trigonometric and circular functions and use them to model and solve problems.
  - Analyzes the relationships among the unit circle in the coordinate plane, circular functions, and the trigonometric functions.
  - Recognizes and translates among various representations (e.g., written, numerical, tabular, graphical, algebraic) of trigonometric functions and their inverses.
  - Recognizes and uses connections among significant properties (e.g., zeros, axes of symmetry, local extrema) and characteristics (e.g., amplitude, frequency, phase shift) of a trigonometric function, the graph of the function, and the function's symbolic representation.
  - Understands the relationships between trigonometric functions and their inverses and uses these relationships to solve problems.
  - Models and solves a variety of problems (e.g., analyzing periodic phenomena) using trigonometric functions.
  - Uses graphing calculators to analyze and solve problems involving trigonometric functions.

- SLO6. Analyze and synthesize information concerning polynomial, rational, radical, absolute value, and piecewise functions and uses them to model and solve problems.
o Recognizes and translates among various representations (e.g., written, tabular, graphical, algebraic) of polynomial, rational, radical, absolute value, and piecewise functions.

o Describes restrictions on the domains and ranges of polynomial, rational, radical, absolute value, and piecewise functions.

o Makes and uses connections among the significant points (e.g., zeros, local extrema, points where a function is not continuous or not differentiable) of a function, the graph of the function, and the function's symbolic representation.

o Analyzes functions in terms of vertical, horizontal, and slant asymptotes.

o Solve equations and inequalities using a variety of methods (e.g., tables, algebraic methods, graphs, use of a graphing calculator), and evaluates the reasonableness of solutions. Models situations using polynomial, rational, radical, absolute value, and piecewise functions and solves problems.
Appendix 2: TEKS for Precalculus (located at http://ritter.tea.state.tx.us/rules/tac/chapter111/ch111c.html)

§111.35. Precalculus (One-Half to One Credit).

(a) General requirements. The provisions of this section shall be implemented beginning September 1, 1998, and at that time shall supersede §75.63(bb) of this title (relating to Mathematics). Students can be awarded one-half to one credit for successful completion of this course. Recommended prerequisites: Algebra II, Geometry.

(b) Introduction.

(1) In Precalculus, students continue to build on the K-8, Algebra I, Algebra II, and Geometry foundations as they expand their understanding through other mathematical experiences. Students use symbolic reasoning and analytical methods to represent mathematical situations, to express generalizations, and to study mathematical concepts and the relationships among them. Students use functions, equations, and limits as useful tools for expressing generalizations and as means for analyzing and understanding a broad variety of mathematical relationships. Students also use functions as well as symbolic reasoning to represent and connect ideas in geometry, probability, statistics, trigonometry, and calculus and to model physical situations. Students use a variety of representations (concrete, pictorial, numerical, symbolic, graphical, and verbal), tools, and technology (including, but not limited to, calculators with graphing capabilities, data collection devices, and computers) to model functions and equations and solve real-life problems.

(2) As students do mathematics, they continually use problem-solving, language and communication, connections within and outside mathematics, and reasoning (justification and proof). Students also use multiple representations, technology, applications and modeling, and numerical fluency in problem-solving contexts.

(c) Knowledge and skills.

(1) The student defines functions, describes characteristics of functions, and translates among verbal, numerical, graphical, and symbolic representations of functions, including polynomial, rational, power (including radical), exponential, logarithmic, trigonometric, and piecewise-defined functions. The student is expected to:

(A) describe parent functions symbolically and graphically, including f(x) = xn, f(x) = 1/n x, f(x) = loga x, f(x) = 1/x, f(x) = ex, f(x) = |x|, f(x) = ax, f(x) = sin x, f(x) = arcsin x, etc.;
(B) determine the domain and range of functions using graphs, tables, and symbols;

(C) describe symmetry of graphs of even and odd functions;

(D) recognize and use connections among significant values of a function (zeros, maximum values, minimum values, etc.), points on the graph of a function, and the symbolic representation of a function; and

(E) investigate the concepts of continuity, end behavior, asymptotes, and limits and connect these characteristics to functions represented graphically and numerically.

(2) The student interprets the meaning of the symbolic representations of functions and operations on functions to solve meaningful problems. The student is expected to:

(A) apply basic transformations, including $a \cdot f(x)$, $f(x) + d$, $f(x - c)$, $f(b \cdot x)$, and compositions with absolute value functions, including $|f(x)|$, and $f(|x|)$, to the parent functions;

(B) perform operations including composition on functions, find inverses, and describe these procedures and results verbally, numerically, symbolically, and graphically; and

(C) investigate identities graphically and verify them symbolically, including logarithmic properties, trigonometric identities, and exponential properties.

(3) The student uses functions and their properties, tools and technology, to model and solve meaningful problems. The student is expected to:

(A) investigate properties of trigonometric and polynomial functions;

(B) use functions such as logarithmic, exponential, trigonometric, polynomial, etc. to model real-life data;

(C) use regression to determine the appropriateness of a linear function to model real-life data (including using technology to determine the correlation coefficient);

(D) use properties of functions to analyze and solve problems and make predictions; and

(E) solve problems from physical situations using trigonometry, including the use of Law of Sines, Law of Cosines, and area formulas and incorporate radian measure where needed.
(4) The student uses sequences and series as well as tools and technology to represent, analyze, and solve real-life problems. The student is expected to:

(A) represent patterns using arithmetic and geometric sequences and series;

(B) use arithmetic, geometric, and other sequences and series to solve real-life problems;

(C) describe limits of sequences and apply their properties to investigate convergent and divergent series; and

(D) apply sequences and series to solve problems including sums and binomial expansion.

(5) The student uses conic sections, their properties, and parametric representations, as well as tools and technology, to model physical situations. The student is expected to:

(A) use conic sections to model motion, such as the graph of velocity vs. position of a pendulum and motions of planets;

(B) use properties of conic sections to describe physical phenomena such as the reflective properties of light and sound;

(C) convert between parametric and rectangular forms of functions and equations to graph them; and

(D) use parametric functions to simulate problems involving motion.

(6) The student uses vectors to model physical situations. The student is expected to:

(A) use the concept of vectors to model situations defined by magnitude and direction; and

(B) analyze and solve vector problems generated by real-life situations.
### Table 1

**Comparison Between Traditional and Virtual Classroom**

<table>
<thead>
<tr>
<th></th>
<th>Traditional Classroom</th>
<th>Virtual Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets at Fixed Times</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Requires a brick and mortar classroom</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Allows student to incrementally cover Course Content and move at his/her own pace.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Feedback is provided instantaneously and/or prescriptive lessons are provided to help the student obtain mastery.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>The course covers and assesses the content of the subject in both depth and breadth required by the accreditation authority.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The course design allows for students to achieve and demonstrate their learning through more than one path.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>The course requires access to the internet and the use of a personal computer.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>The course helps utilize and familiarity with 21st Century Skills.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>The course provides appropriate student - to - teacher and student - to - student interaction.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The course provides access to students who are not within commuting distance of the school.</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>The course makes use of asynchronous and synchronous communication.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>