This course of study outlines the sequence of learning activities to help you develop competence in the subject area of Mathematics Technology. Your competence will be assessed as you complete a series of performance tasks. This course of study may take up to four weeks to complete depending on your educational background, work experience, and the time you are able to dedicate to your studies. Consult with your mentor if you wish to accelerate through this course of study. Completing your assessments within the required timeline keeps you on pace for satisfactory academic progress and graduation.

Introduction

This course of study will help you not only strengthen your math thinking and communications skills but also develop problem-solving strategies and computer skills. Consider the value of engaging your students in math and computer applications. When possible, plan your instruction around big ideas rather than isolated skills. As you work through the course of study activities, be aware of potential student difficulties and your potential interaction with the math content.

Overview

You will now continue your study of mathematics pedagogy. The assessment for the Mathematics Technology Course of Study is a performance assessment that focuses on the construction of original lesson plans using appropriate research-based, age-specific pedagogies. Specifically, this course of study focuses on the appropriate use of technology in mathematics classrooms. Do you know how to use a graphing calculator? Do you know how to use Microsoft Excel? There are several great dynamic geometry software packages available. Have you ever used Cabri or the Geometer's Sketchpad? Texas Instruments' (TI's) calculator-based ranger and calculator-based laboratory are two excellent real-world data-collection devices. Have you heard of or used these before? If not, fear not; you will soon learn how to effectively incorporate these technologies into your lesson plans.

You will need to infuse these technologies into selected mathematics teaching topics that include proofs, graphing calculator usage, dynamic geometry software, data collection and analysis, and the use of appropriate justifications within pedagogy. The use of appropriate technology in math classrooms is one of the National Council of Teachers of Mathematics' (NCTM) tenets. You will now explore how to go about harnessing the power of these tools to capture students' attention and to motivate them to learn.

The Mathematics Technology performance assessment focuses on the construction of original lesson plans using appropriate research-based, age-specific pedagogies.

Note: Prior to starting the first section, "Preparing for Success," you should carefully read through the requirements of this course of study with the intent of acquiring an overview of what is expected of you. Such an overview will ensure that you are prepared for the pre-clinical experiences found throughout this course of study.
Be a Successful Mathematics Teacher

URL:
Study Skills Self Help Information
http://www.ucc.vt.edu/stdysk/stdyhlp.html

Whether you are initiating, changing, or expanding your career, what you learn throughout your mathematics program will help you internalize your skills and abilities and transfer your love and knowledge of math to your students in the classroom.

- **Get the Tools You Need**: Enroll in Teaching Mathematics Grades 5-12 from the course of study.
- **Build Your Motivation and Confidence**: If you are not already a teacher of record with your own classroom, spend time substituting and tutoring in schools. Get to know firsthand the challenges and joy of working with young students. As a teacher, you will need to know how to help your students learn and demonstrate competence in math. If you are interested, view videos to help you develop confidence in your abilities.
- **Apply Math to the Real World**: Enjoy learning how to apply your knowledge and skills. From consumer math to calculus, most students want the question "why do I need to know this?" answered. The texts and resources that you will have in your mathematics programs are rich with applications. Do not skip them. People come to math with different strengths and approaches. Building upon what you already know through your real-life experiences will inspire and enhance your creativity in teaching.
- **Maximize Your Time**: Test your prior knowledge. WGU allows candidates, under certain conditions, to accelerate through the program. This course of study has pacing suggestions to keep you on track with SAP. However, if you already have mastered the concepts and can move faster, please do so. Set goals, make a plan, and reward yourself often. Getting a degree is challenging, so make a plan that works for you.

*Note: Please be aware that some of the TaskStream math graders are using Macs, which evidently do not process Microsoft Equation Editor information in the same way that PCs do. Plan to submit PDFs when equations or graphs are involved and verify that all looks well prior to submission; this will eliminate the potential of problems.*

**Competencies**

This course of study covers the following competencies:

**Competency 602.5.1: Teaching Methods-Mathematics (Secondary)**
The graduate provides effective, research-based mathematics instruction.

**Competency 202.1.1: Number Systems and Algebraic Structures**
The graduate understands the real number system and its relationship to the complex number system; understands important algebraic structures; and understands the significance of
functions in the study of number systems.

**Competency 202.2.1: Geometry (MS)**
The graduate understands synthetic, analytic, and transformational geometries and their relationship to measurement, and understands how geometry and measurement develop from intuitive investigations to formal arguments.

**Competency 202.4.1: Precalculus**
The graduate understands and applies the principles of trigonometry; mathematical modeling; and logarithmic, exponential, polynomial and rational functions.

**Teaching Dispositions Statement**
Please review the [Statement of Teaching Dispositions](#).

**Required Learning Resources**

- Teaching Mathematics Grades 5-12 from Pearson. Enrollment in this resource provides you with access to the following e-texts:

**Preparing for Success**

To successfully complete this course of study, you need the appropriate resources to help with your learning. You should also prepare a calendar to schedule time devoted to your studies. Share your calendar with family and friends so they are aware of your obligations.

**Acquire Learning Resources**

Arrange to obtain the learning resources listed in the "Required Learning Resources" section so there will be no delay in your studies. These items are essential for you, as this document will guide you in the use of these materials. Some of these items must be shipped to you, so be sure that your mailing address information is current. If you click on your name in your Degree Plan, you can check your contact information.

**Enroll in Teaching Mathematics**

- [CourseCompass](#)

Enroll in the Teaching Mathematics Grades 5-12 learning resource found in your Degree Plan. You may have already accessed this resource for other courses of study. If you have not, you do not want to wait until you are ready to study only to discover there is a technical problem preventing your access to these valuable resources. These are independent study courses provided to you by WGU through enrollment under the Degree Plan resource title "Teaching
Mathematics Grades 5-12.

The multimedia textbooks below are included and contain videos, practice problems, and quizzes.


After enrolling in this course, you will be e-mailed access information to the Pearson CourseCompass website. You will be sent a link to the site with your username and password. When you log in to this website, you access the Teaching Mathematics Grades 5-12 resource, e-books, MyEducationLab, practice tests, and the above e-texts.

*Note: Should you desire hard copies of these e-texts, the WGU Bookstore has these books available for immediate purchase and delivery. You may shop at other online bookstores, but be sure to order early and use the correct ISBN to get the correct edition.*

**Access the Companion Website**

- [Elementary and Middle School Mathematics Companion Site](#)

If you find that you need additional practice taking multiple choice tests, the website listed above contains additional chapter tests. You can "jump to" any chapter to explore a variety of additional resources and also take practice tests.

**Purchase an Appropriate Calculator**

- [TI Connectivity Kit](#)

*Note: This activity is only necessary if you do not already own an appropriate calculator.*

The TI-84 Plus graphing calculator; its predecessors TI-82 Plus, TI-83, or TI-83 Plus; or equivalent calculators of other brands are recommended. Graphing calculators that have built-in computer algebra systems (CAS) are not allowed on objective assessments, so it is recommended that you do not use such a calculator while working on the mathematics activities and topics. To download the TI screenshots to your computer, you will need a TI Connectivity Kit, available at the above URL.

**Accessing Performance Tasks**

- [TaskStream](#)

To request access for the performance tasks, follow these steps:
1. Log in to your MyWGU Student Portal.
2. Go to the "My Degree Plan" tab.
3. In the list below "Course Details," find the assessment that you are working on.
4. In the "Assessment Preparation" column, click "Required Tasks."
5. A new window will come up. If there are other considerations you would like to inform
   the Assessment Delivery Team about, discuss them in the "Other Considerations" box
   that appears and then click “Continue.” If not, simply click “Continue.”
6. A request will be sent to your mentor for approval.
7. Once your mentor has approved your request, our Assessment Delivery Team will open
   the required tasks in TaskStream. You will log in to TaskStream to receive the
   instruction, see the rubric, and submit your tasks for grading.

Access the WGU Library

This course of study utilizes resources located in the WGU Library E-Reserves, with articles
available for you to download. Follow these directions for accessing the WGU Library
E-Reserves.

Participate in the Message Board

In the lower right-hand corner of the course of study screen there is a message board area.
Throughout your studies, you will want to follow the questions, observations, and responses of
the other students and the expert advice of the course instructor. If you have questions of your
own, do not hesitate to use this resource to get those answered as you develop your
competence.

Get into the habit of visiting the message board on a regular basis. Read the posts covering the
topics you are studying. Post your ideas about the topics as well as any questions you have.
Where other students have posted questions, feel free to reply with any answers or information
you have to contribute. This is important for the development of your competence in this course
of study.

Take advantage of the learning opportunities through communication with your course instructor
and other students. This is a way to ask questions and get concepts clarified by your peers and
by the course instructor. Watch for announcements of web conferences and other opportunities
to meet your peers online. You can learn substantially more when working with others than you
can learn in isolation.

Best Practices Tool: Get a Study Notebook

It is suggested that you create a paper or digital notebook for your study notes as you go
through this course of study. Use organizers or dividers to separate your work. You may want to
include a glossary, study notes, topics to revisit, and helpful websites.

One of the features of the web-enabled course of study is a "Notes" element in the lower
right-hand navigation area. This feature allows you to keep notes organized by topic. You
should get into the habit of using it throughout the course of study. You have the ability to take
these notes online through the web-enabled course of study.
A notebook makes your learning more active. It also provides an excellent source of important materials to review prior to demonstrating your competence through the assessment. Whenever prompted throughout this course of study to reflect upon what you have learned, record your answers, thoughts, and reactions in your notebook.

**Real and Complex Numbers Overview**

After completing the following activities, you will be able to demonstrate an understanding of the real number system and its relationship to the complex number system, important algebraic structures, and the significance of functions in the study of number systems. The primary focus will be on exploring the ways the complex number system is an extension of the real number system. What is the difference between real numbers and complex numbers? Why were complex numbers invented? What sorts of problems were they designed to help people solve? What, if any, real-world situations use complex numbers? You will be able to

- clearly define what constitutes a real number,
- clearly define what constitutes a complex number,
- use multiple examples to explain how complex numbers combine under the operations of addition and multiplication,
- use multiple examples to explain the differences that exist between how real and complex numbers combine under the operations of addition and multiplication,
- include your explanation algebraic and graphical interpretations that support the aforementioned assertions, and
- provide the appropriate justification for all of the algebraic manipulations.

Think about these topics as you complete the following activities, with an aim towards ultimately writing an essay that compares and contrasts the real numbers with the complex numbers.

**Competencies covered by this subject**

202.1.1 - Number Systems and Algebraic Structures
The graduate understands the real number system and its relationship to the complex number system; understands important algebraic structures; and understands the significance of functions in the study of number systems.

602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

**Number System Exploration**

The complex number system is different from the real number system in a variety of important ways. Is one of these sets of numbers a subset of the other? If so, which one? How do you perform operations on complex numbers? Addition, subtraction, and multiplication are all fairly straightforward, but what about division? Do you recall how to divide two complex numbers? Could you explain the rationale for this process to a student?

**Real Versus Complex Numbers**

Read chapter 1 ("The Challenge of Teaching") in *Teaching Secondary Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.
It is recommended that you look through the "References" section on pages 496-515 in *Teaching Secondary Mathematics*. Should you desire a more comprehensive exploration of selected topics, this section will provide you with many sources of additional information. Keep this in mind while you work on each of the tasks associated with this assessment.

**Developing Concepts of Exponents, Integers, and Real Numbers**

Read chapter 23 ("Developing Concepts of Exponents, Integers, and Real Numbers") in *Elementary and Middle School Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

**Real and Complex Numbers**

- CourseCompass

View the Teaching Mathematics Grades 5-12 resource topic case 2. Review all of the material that is provided.

As you are guided through an exploration of provided learning tools, you should ponder the following prompts with the intent of constructing and internalizing the desired understandings. These understandings were previously identified under the previous topic description. While you engage in this material, reflect upon the following questions and write your answers in your study notebook:

- What is a real number?
- How many subsets can you identify that belong to the set of all real numbers?
- What is required for membership into the set of all real numbers?
- What is a complex number?
- What is the "form" of all elements belonging to the set of all complex numbers? (Hint: There is an imaginary and real part.)
- What is required for membership into the set of all complex numbers?
- Compare and contrast the differences (and similarities) with regard to how complex numbers combine under the operations of addition and multiplication. (Aside: What about division?)
- Can you divide two complex numbers?
- What is a complex conjugate?

Although beyond the scope of this activity, real and complex numbers are important concepts in mathematics. How would you respond to the aforementioned questions from an algebraic perspective? How would you respond to the aforementioned questions from a graphical perspective? How many algebraic justifications can you identify? (Hint: associative property for addition, etc.)

**National and State Mathematics Standards**

- College Algebra Tutorial 12: Complex Numbers
- Complex Numbers: Introduction
These web resources will allow you to review, compare, and contrast the relevant content that is associated with real and complex numbers.

**Study Tips**

TaskStream provides tools that allow you to identify national and state mathematics standards. You should be able to make connections between such standards and the lesson plans that you construct. To access these tools, log in to TaskStream, click on “Standards Manager” (under “Resources”), and then click on “Browse Standards.” You now can choose either “View State Standards” or “View U.S. National Standards” and then explore the desired standards. Teachers must be able to make connections between the lessons that they construct and the corresponding standards. Be sure to include relevant state and national standards whenever prompted to do so.

As you engage in these materials, reflect upon the following questions:

- What must be true of elements belonging to the set of all real numbers?
- What must be true of elements belonging to the set of all complex numbers?
- Why is a line used to graph the set of all real numbers whereas a plane (Argand diagram) is used to graph the set of all complex numbers?

Record your reflections in your study notebook.

**Performance Task 202.1.1-02**

Carefully follow the directions found in TaskStream in order to complete performance task 202.1.1-02. Be sure to include detailed information and respond to each prompt. The rubric by which the task will be graded is also found in TaskStream. Review it to be sure that you have included all of the relevant information required.

Write an essay (suggested length of two pages) in which you compare and contrast the real number system and the complex number system.

**Prime and Composite Numbers**

After completing the following activities, you will be required to demonstrate an understanding of the mathematical definitions for prime and a composite numbers. The primary focus will be on distinguishing between these definitions and proving a relevant theorem via their application. You will be able to

- provide a mathematical definition of a prime number,
- provide a mathematical definition of a composite number,
- provide a theorem that requires the application of the definition for prime and composite
numbers,
  - explain how to prove the aforementioned theorem, and
  - provide the appropriate justification for all of the algebraic manipulations.

Be sure to think about these topics as you engage in the materials. What is a prime number? What is a composite number? Is 1 prime? Why or why not? Is 2 prime? Are all primes odd? Why are primes important? What are primes used for? Have you come across any theorems that deal with primes and composites? Can you clearly articulate the difference between these to students learning about them?

Competencies covered by this subject
202.1.1 - Number Systems and Algebraic Structures
The graduate understands the real number system and its relationship to the complex number system; understands important algebraic structures; and understands the significance of functions in the study of number systems.
602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

Prime and Composite Numbers Overview
You will now begin your exploration of primes and composites in earnest. What is meant by the term the *Sieve of Eratosthenes*? What is it used for? Why might it be valuable? Where do primes get used? Can you write any composite number as the product of primes? Why or why not? Why would being able to do so be useful? What is the relationship between primes and greatest common factors (GCFs) or least common multiples (LCMs)?

Prime and Composite Numbers Theorem
Read chapter 2 ("Long-Range and Short-Range Planning") in *Teaching Secondary Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Recommended Reading

Almost any undergraduate calculus, discrete mathematics, geometry, number theory, abstract algebra, real analysis, probability and statistics, or mathematical statistics textbook will suffice for the identification of an appropriate theorem for the upcoming performance task.

Prime Versus Composite Numbers

- [Factoring Numbers](#)
- [MathPath: Methods of Proof](#)
- [Notes on Methods of Proof](#)

The first website above will allow you to review relevant content that is associated with prime and composite numbers. As you engage in this material, ask yourself the following questions and record your answers in your study notebook:

- What is a prime number?
What is a composite number?

Provide specific examples of primes and composites. It is important that you clearly identify the method of proof that you plan to employ in this activity. Recall that the primary methods of proof used in mathematics include direct proofs; proof by contradiction and reductio ad absurdum; the contrapositive and equivalent forms; existence proofs; uniqueness proofs; mathematical induction; etc. It is recommended that you go to the listed web resources above for a description of these methods (and more).

Make sure that you provide the appropriate justifications, which may include the commutative properties, associative properties, identity properties, inverse properties, distributive properties, etc. How many types of mathematical proofs can you identify? The proof of many theorems requires the application of the mathematical definition for a prime and composite number. For this activity, you will need to select a theorem that requires the application of the mathematical definition for a prime and composite number. Which theorem you select will depend upon your level of comfort with the surrounding mathematics imbedded in the theorem and its proof. Some theorems are easier to understand than others. Which theorem should you select to prove for this activity? The proof of the theorem you select should involve a step or steps where the mathematical definition for a prime and composite number arises as a justification for a step or steps in a proof where the divisibility of one number into another is desired. Such justification may also be used for demonstrating a lack of divisibility.

What is divisibility? Recall that if \( a \) and \( b \) are any nonzero integers, \( a \mid b \) (read \( a \) divides \( b \)) if and only if there exists an integer \( k \) such that \( b = ka \). In other words, \( b \) is divisible by \( a \) if such a relationship can be established. If \( b \) is a prime number, then what values can \( k \) and \( a \) take on? If \( b \) is a composite number, then what values can \( k \) and \( a \) take on? It is this key concept that should arise in the selected theorem. Where should you look for the desired theorem? A good starting place would be to reflect upon all of the theorems that you needed to either apply or prove in prior mathematics assessments. You can explore the provided web resources for such theorems. Also, almost any undergraduate calculus, discrete mathematics, geometry, number theory, abstract algebra, real analysis, probability and statistics, or mathematical statistics textbook will suffice for the identification of the desired theorem for this activity.

**Performance Task 202.1.1-16**

Carefully follow the directions found in TaskStream in order to complete performance task 202.1.1-16. Be sure to include detailed information and respond to each prompt. The rubric by which the task will be graded is also found in TaskStream. Review it to be sure that you have included all of the relevant information required.

For task 202.1.1-16, you will prove a theorem involving primes and composites.

**Geometry**

After completing the following activities, you will be required to construct an original lesson plan
using appropriate research-based, age-specific pedagogies for which the focus is to prove a given theorem from Euclidean geometry. You will

- learn how to properly construct Euclidean geometry proofs,
- be able to pose relevant questions,
- be able to anticipate relevant questions, and
- construct a learning environment that has students discover, develop, derive, and conceptually understand geometry proofs.

What difficulties do you envision your students might have as they set about doing proofs? Did you enjoy proofs when you were studying geometry? Why or why not? What can be done to help students who struggle with proofs?

Competencies covered by this subject
202.2.1 - Geometry (MS)
The graduate understands synthetic, analytic, and transformational geometries and their relationship to measurement, and understands how geometry and measurement develop from intuitive investigations to formal arguments.
602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

Geometric Lessons
You will now turn your attention to how to effectively teach geometric topics. What are some best practices you should follow when teaching geometric topics? How can you motivate students to study geometry? What does Van Hiele levels of geometric reasoning mean? Why are they important? How do they factor into the sequencing of geometric explorations and activities?

Teaching More Effective Lessons

Read chapter 3 ("Teaching More Effective Lessons") in *Teaching Secondary Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Geometric Thinking and Geometric Concepts

Read chapter 20 ("Geometric Thinking and Geometric Concepts") in *Elementary and Middle School Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Note: There are 125 enrichment units for the secondary school classroom in *Teaching Secondary Mathematics*. It is recommended that you go to the table of contents on pages vii-viii to identify the enrichment units that are most commensurate with the requirements set forth in the upcoming performance task. A review of these units may help to stimulate ideas for the lesson plan that you need to construct for the upcoming performance task. For this section, you should focus on those units that deal with topics from geometry (e.g., enrichment units 25, 111, and 114).
Geometry Video and Reflection

- CourseCompass

After logging in to the Teaching Mathematics Grades 5-12 website, click on the "Teaching Mathematics" resource link found on the left-hand side of the page. Then click on the "Case 1" link and review all of the material that is provided in this topic. This series of links presents you with snippets of video from a real-world geometry class and then asks you to reflect upon various aspects that you saw in the video. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Synthetic Geometry

- Appetizers and Lessons for Mathematics & Reason

How should you acquire geometric understandings? You should review the provided content at the web resource listed above. Briefly, synthetic geometry involves the use of theorems. As you review this material, brainstorm ways in which you can help students discover, develop, and derive the mathematical concepts that are associated with the performance task. In what ways can you help students construct their own understandings of the desired content and skills? You will need to use a prescribed lesson plan to help you construct an original lesson plan to prove a given theorem in Euclidean (synthetic) geometry. The lesson plan should include an appropriate title, relevant definitions, a purpose, lesson objectives, pre-instructional techniques, instructional procedures and strategies including the proof, and anticipated discourse.

Performance Task 202.2.1-06

- TaskStream

Carefully follow the directions found in TaskStream in order to complete performance task 202.2.1-06. Be sure to include detailed information and respond to each prompt. The rubric by which the task will be graded is also found in TaskStream. Review it to be sure that you have included all of the relevant information required.

For task 202.2.1-06, you will create a lesson plan that guides students to prove a geometric theorem.

Precalculus

Effective mathematics instruction requires the capacity to derive and prove mathematical relationships using the appropriate logic and justifications. You will now take a look at how to begin teaching proofs in the context of verifying a trigonometric identity. What sorts of prior knowledge should students possess before attempting to verify a trigonometric identity? What potential struggles or difficulties do you foresee that students might have as they attempt to do this for the first time?

Competencies covered by this subject
202.4.1 - Precalculus
The graduate understands and applies the principles of trigonometry; mathematical modeling; and logarithmic, exponential, polynomial and rational functions.

602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

**Trigonometric Relationships**
After completing the following activities, you will be asked to demonstrate an understanding of selected principles of trigonometry. The primary focus will be on the application of these principles to prove a given mathematical identity. You will be able to

- provide a mathematical expression that involves trigonometric identities,
- provide the appropriate justification for all of the algebraic manipulations involved in proving that the identity is true,
- provide a critical analysis of the thought process that was employed to prove a given trigonometric identity, and
- identify difficulties that you encountered while constructing a proof for a given trigonometric identity.

Think about these ideas as you engage in the materials that follow. Do you recall how to begin a proof? Could you explain to a student why proofs require rigor and precision? Why is an example not the same as a proof? What can you do to encourage students to stick with it and persevere if they get stuck? What proof strategies could you suggest that they employ?

**Role of Problem Solving**

- [Table of Trigonometric Identities](#)

Read chapter 4 (“The Role of Problem Solving”) in *Teaching Secondary Mathematics* and review the website provided above.

This web resource will allow you to review the relevant trigonometric identities required to complete the upcoming performance task. As you engage in this material, ask yourself the following questions:

- What is an identity?
- What is a mathematical identity?
- What is a trigonometric identity?

Since there are many identities in mathematics, it is extremely important that mathematics teachers be able to prove such relationships. If you are given a mathematical identity, you are not to start your proof with the assumption that the given mathematical identity is true. Consider the situation provided below.

Prove the following:

Mathematical Relationship A = Mathematical Relationship B
You have one of two possible options for starting this proof:

- Option 1: Start with Relationship A and show that Relationship B can be derived from Relationship A using the appropriate justifications; or
- Option 2: Start with Relationship B and show that Relationship A can be derived from Relationship B using the appropriate justifications.

It is wrong to start with Relationship A = Relationship B. Many students make this mistake. Starting with this assumption, they algebraically manipulate both sides of the expression so that they end up with something that looks like a constant = constant. You cannot assume that which must be proved!

**Performance Task 202.4.1-08**

- **TaskStream**

Carefully follow the directions found in TaskStream in order to complete performance task 202.4.1-08. Be sure to include detailed information and respond to each prompt. The rubric by which the task will be graded is also found in TaskStream. Review it to be sure that you have included all of the relevant information required.

For this task, you will prove a trigonometric identity.

**Educational Technologies**

The use of appropriate technology in math classrooms is advocated by the NCTM. In fact, the Technology Principle is one of the core principles espoused by the NCTM. You will now begin to explore how to go about harnessing the power of technology tools to capture students' attention; empower students mathematically, and motivate students to learn. Why would you want to use technology to teach math? Are there times when its use is perhaps not appropriate? When might that be?

Competencies covered by this subject
602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

**Educational Technology Overview**

After completing the following activities, you will be required to construct an original lesson plan using appropriate, research-based, age-specific pedagogies with a focus on exploring how to solve systems of linear equations involving two equations with two unknowns by using selected educational technologies. You will be able to

- describe how to fully integrate a variety of educational technologies with clear and easy-to-follow directions for students;
- discuss the visual and computational advantages of using a variety of educational technologies in the constructed lesson;
- demonstrate the three possible types of solutions that can be obtained from a system of two equations with two unknowns;
- construct graphical representations that support the aforementioned assertions with
regard to the three possible types of solutions;
- explain how the content can be applied to other mathematics or to real-world examples; and
- construct a learning environment that has students discover, develop, derive, and conceptually understand how to solve systems of equations with two unknowns using selected educational technologies.

Reflect upon these skills and abilities as you engage in the upcoming materials. Ask yourself about your comfort level with technology. You are attending an online university, so presumably you feel fairly comfortable using technology, but you may not have ever done so in a math classroom. What challenges do you foresee as you embark upon this technology integration journey? What issue do you envision your students might have?

**Using Technology to Enhance Mathematics Instruction**

Read chapter 5 ("Using Technology to Enhance Mathematics Instruction") in *Teaching Secondary Mathematics*. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

*Note: There are 125 enrichment units for the secondary school classroom in Teaching Secondary Mathematics. It is recommended that you go to the table of contents on pages vii-viii to identify the enrichment units that are most commensurate with the requirements set forth in the upcoming performance task. A review of these units may help to stimulate ideas for the lesson plan that you need to construct for the upcoming performance task. For this section, you should focus on those units that employ technology to explore relevant topics (e.g., enrichment unit 11).*

**View Teaching Math Resource: Case 5**

- **CourseCompass**

After logging in to the Teaching Mathematics Grades 5-12 website, click on the "Teaching Mathematics" resource link found on the left-hand side of the page. Then click on the "Case 5" link and review all of the material that is provided in this topic. This series of links presents you with snippets of video from a real-world mathematics class and then asks you to reflect upon various aspects that you saw in the video. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

**Solving a System of Equations Using Technology**

- **Gaussian Elimination**
- **Systems of Linear Equations: Definitions**

These web resources will show you how to solve a system of equations using an appropriate method (i.e., Gaussian elimination) and recognize the different types of solutions that you can
Creating Meaning for and With the Graphing Calculator

Read the following journal article, available in the WGU e-reserve:


In this activity, you will focus on the appropriate use of educational technology (i.e., a graphing calculator or a computer) to solve a problem. An example is supplied below of resources for using technology to teach the mathematical topic of systems of linear equations. What follows is an exploration of the possible types of solutions that you may acquire from a system of two linear equations with two unknowns. Symbolically, if \( x \) and \( y \) are the two unknown variables and \( A, B, C, D, E, \) and \( F \) are any real constant, the system of two linear equations with two unknowns becomes the following:

- \( Ax + By = C \)
- \( Dx + Ey = F \)

You will need to be able to solve for both \( x \) and \( y \) using an appropriate graphing calculator. There are three types of solutions that can be obtained from such a system of linear equations. What are they? The best way to think about this is to think about it graphically. You have two lines on a Cartesian plane where you are attempting to identify the different ways in which the lines can be positioned. You should first solve this linear system of equations by hand and then use an appropriate graphing calculator or software program.

**Graphing Calculators**

- [Graphing Calculators](#)

Which graphing calculator should you use? The Texas Instrument (TI) 83 or 84 series of graphing calculators are recommended, since they are the ones used most often in middle schools and high schools. Instructions on how to perform calculations are provided in most manuals that come with the graphing calculator when you purchase it.

**Math With Microsoft Excel**

- [Help for Excel 2007](#)
- [Excel Tutorial](#)
- [Graphing With Excel](#)
- [Physics Laboratory Excel Tutorials](#)

Which software program should you use? This is a much more difficult question to answer than which graphing calculator you should use. There are many to choose from. If you are using Microsoft Office Suite, then you will probably have access to Excel. With a little creativity, you can use Excel to explore the three types of solutions. If you go to the web resources shown above, you will find a wealth of information on Excel. These web resources will provide you with the basics. One of the easiest ways to use Excel to solve a system of equations is to use
matrices.

As you engage in these materials, reflect and record your thoughts about the following questions:

- What are advantages to using technology to teach mathematics?
- What are the potential disadvantages?
- What connections can you make between this content and other mathematics or real-world examples?
- What are ways in which you can help students discover, develop, and derive mathematical concepts?
- In what ways can you help students construct their own understandings of the desired content and skills?

**Graphing Calculator Versus the Computer, Part I**

You will soon be asked to teach how to use the graphing calculator and the computer to solve a given problem from the secondary mathematics curriculum. As you are guided through an exploration of provided learning tools, you should ponder the following questions with the intent of constructing and internalizing the desired understandings. These understandings were previously identified under prior learning topics.

- What are ways in which you can help students integrate technology in selected mathematics lessons?
- In what ways can you help children construct their own understandings of desired content and skills using technology?

**Graphing Calculator Versus the Computer, Part II**

The following are some prompts for you to consider:

- What are the similarities and differences between the potential use for a graphing and a scientific calculator?
- What is the equation for a line?
- Lines can be graphed on a Cartesian plane where the x-axis is the abscissa and the y-axis is the ordinate. Describe in your own words what the slope (i.e., change in y value over change in x) and the abscissa intercept represent.
- What does it mean for two lines to be parallel? How many solutions exist for this case? Explain.
- What does it mean for two lines to intersect each other? How many solutions exist for this case? Explain.
- What does it mean for two lines to coexist in the same region of space (in other words, two lines that lie on top of each other)? How many solutions exist for this case? Explain.
- For the aforementioned three cases, how could you use a graphing calculator or software program to explore the existence of solutions for each set of linear equations?
- What connections can you make between the employed technologies and the mathematics content that is explored in this activity with real-world applications?

**Performance Task 602.5.1-06**
Follow the directions found in TaskStream in order to complete performance task 602.5.1-06

You will need to use a prescribed lesson plan template to construct an original lesson plan appropriate for a secondary mathematics curriculum. The lesson plan will incorporate the use of a graphing calculator or computer (i.e., solve a system of two linear equations with two unknowns using a graphing calculator).

### Mathematical Modeling

You now will turn to a discussion of a real-world application that combines data analysis with statistics and the use of technology. Such real-world problems are critical to problem-based learning and can serve to clearly illustrate the power that mathematics has to help people understand the world around them. By showing students concrete examples of when they will use mathematics, you can help capture their interest and motivate your lessons.

Competencies covered by this subject

602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

### Mathematical Modeling

There is a lot to digest here, so take your time and try to recall the techniques that you will review. You have very likely been exposed to these concepts before but perhaps without the context that will now be provided. If you have trouble following along, just think how confusing this could be to a student. How might you help break this information apart into more easily-digestible pieces? What prerequisite skills must be mastered prior to moving on to new material? How will you ascertain whether or not your students have gained those skills?

After completing the following activities, you will be required to construct an original lesson plan using appropriate research-based, age-specific pedagogies for which the focus is on using selected educational technologies to construct mathematical models to be used to make future predictions. You will be able to

- provide appropriate data collection and management strategies;
- describe how to fully integrate a variety of educational technologies with clear and easy-to-follow directions for students;
- lead students who are unfamiliar with linear regression through the steps to fit a line using least squares. Note: Middle grades students should be led to rely on technology for the computationally-intense learning, while high school students may be led through the technology, the hand computation, or both;
- assess the quality of a mathematical model using simple statistical measures;
- construct graphical representations that support the aforementioned assertions;
- make future predictions using the obtained mathematical model;
- discuss mathematical factors that might make the aforementioned predictions inaccurate;
- discuss real-world factors that might make the aforementioned predictions inaccurate;
and
• construct a learning environment that has students discover, develop, derive, and conceptually understand how to use selected educational technologies to construct mathematical models to be used to make future predictions.

**Using Technology to Enhance Mathematics Instruction**

Read chapter 5 ("Using Technology to Enhance Mathematics Instruction") and chapter 6 ("Assessment") in *Teaching Secondary Mathematics*.

*Note: There are 125 enrichment units for the secondary school classroom in Teaching Secondary Mathematics. It is recommended that you go to the table of contents on pages vii-viii to identify the enrichment units that are most commensurate with the requirements set forth in the upcoming activity. A review of these units may help to stimulate ideas for the lesson plan that you need to construct for the upcoming assignment. For this section, you should focus on those units that employ technology to explore relevant topics (i.e., enrichment units 119 and 122).*

Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

**Linear Regression Overview**

- Scatter Plots and Regressions
- Linear Regression and Excel
- Ask Dr. Math: Archives

Review the material contained in the first two above web resources about regression. These web resources will provide you with the basics with regard to linear regression, least squares method, scatter plots, and mathematical modeling. What is mathematical modeling? Mathematical modeling allows you to construct mathematical relationships that can be used to make predictions about the real world.

You should think about mathematical modeling as consisting of

- construction of research questions,
- data collection and management,
- results,
- analyses,
- conclusions, and
- future predictions.

**Construction of Research Questions**

Before you undertake any investigation of real-world phenomena, you need to be very clear about the question(s) that are the focus of the investigation. What specific research questions are being investigated?
Data Collection and Management
What methods will be used to collect the data? How much data will be collected? In what ways will you manage the data? Spreadsheets (e.g., Microsoft Excel) are a wonderful way to manage large sets of data. Graphing calculators can also be used to organize data in much the same way that a spreadsheet is used.

Results
What specific quantitative measures do you want to use to explain the real-world data that you are studying? For instance, quantitative measures of central tendency (i.e., mean, median, and mode) and dispersion (i.e., variation, standard deviation, and range) are often used. Mathematical modeling approaches use the least squares method to construct a best fit line $y = mx + b$ where $m$ and $b$ are the best-fit slope and y-intercept, respectively.

Analysis
When performing a linear regression, you must assess the quality of the generated linear model $y = mx + b$. There are a variety of statistical methods that can be used to make such an assessment (i.e., correlation, coefficient of determination, etc.). A quick way to make such an assessment is to use the generated linear model to make future predictions. For high and low values for $x$, does the predicted $y$ make sense? Another quick way to make such an assessment is to superimpose the generated linear model onto a $y$-versus-$x$ scatter plot of the actual data. How close are the data points to the superimposed linear model?

Future Predictions
If the generated linear model is assessed as being credible, you should be able to use the model to make relevant future predictions. Two related concepts involve interpolation and extrapolation. What is interpolation? What is extrapolation? What role do these concepts play in making future predictions? The third web resource above should help to clarify these concepts. Explore the links found on the third web page above and use them to refresh your memory of linear regression, interpolation, and extrapolation.

Linear Regression Applet
- Resources for Teaching Math

Above is a website that allows you to experiment with the processes and procedures used to create regression lines.

In this activity, you will need to perform a linear regression using technology.

Brainstorm ways in which you can help students discover, develop, and derive the mathematical concepts that are associated with this activity. In what ways can you help students construct their own understandings of the desired content and skills?

Study Notebook Assignment
- U.S. POPClock Projection
- Lesson Plan
This is a "homework" assignment. You will not need to submit this activity to TaskStream. Rather, you will create this in your study notebook.

You will need to use the lesson plan template at the link above to construct an original lesson plan to promote an understanding of how linear regression can be used to make future predictions using U.S. census data. The lesson plan should include an appropriate title, relevant definitions, a purpose, lesson objectives, pre-instructional techniques, instructional procedures and strategies, and anticipated discourse. You will use selected technologies to construct a linear model that can be used to make future predictions. If you were to implement the lesson plan you created, would your students have fun? How can you construct the desired classroom dynamic so that students will enjoy learning? If you can make this a fun lesson, it is predicted that students will be much more likely to be engaged.

1. Using the lesson plan template at the link above, create an original lesson plan to assist the learning of linear regression and its application to projecting U.S. census data into the future.
2. Include directions for retrieving historical national population estimates from the U.S. Census Bureau for each 10-year period from 1900 to 1990 from the U.S. Census Bureau POPClock projection at the website listed above.
3. Lead a student who is unfamiliar with linear regression through the steps to fit a line using least squares. Note: Middle grade students should be led to rely on technology for the computationally-intense learning, while high school students may be led through the technology, the hand computation, or both.
4. Apply a linear regression to population growth forecasting.
   a. Use it to predict the population of the United States in 2010 and 2020.
   b. Discuss mathematical factors that might make those predictions inaccurate.
   c. Discuss real-world factors that might make those predictions inaccurate.

Data Analysis of Real-World Data

Technological tools now exist that are specifically designed to gather real-world data. These tools can be used in math classrooms to explore physical phenomena. Students seem to really enjoy "getting their hands dirty," so to speak, as they collect their own data. This allows them to take ownership of the problem-solving process and can be a great motivator.

Competencies covered by this subject
602.5.1 - Teaching Methods-Mathematics (Secondary)
The graduate provides effective, research-based mathematics instruction.

Data Analysis of Real-World Data

How do you learn how to use these data collection devices and software tools? Are there benefits to using such technologies? Can you identify several benefits? One of the benefits of using these technologies is that how you use them can be adapted quite easily for students with special needs or with learning-style preferences. How can these technologies be adapted? The best way to address this question is to identify a special need or learning-style preference and then make the appropriate connections.

After completing the following activities, you will be required to construct a description of how to
use appropriate research-based, age-specific pedagogies for which the focus is on the analysis of real world data using a variety of educational technologies. You will be able to

- explain how selected educational technologies can be used to enhance a mathematics curriculum;
- explain the importance of appropriately integrating these technologies into a mathematics curriculum;
- explain the benefits and potential drawbacks of the technologies’ use;
- provide research that supports the aforementioned assertions;
- adapt such practices to include students with special needs or learning-style preferences;
- construct student projects that incorporate the use of a variety of educational technologies that emphasize data collection, data analysis, and the use of both; and
- construct a learning environment that has students discover, develop, derive, and conceptually understand how to use selected educational technologies that emphasize data collection, data analysis, and the use of both.

Enriching Mathematics Instruction

Review chapter 5 ("Using Technology to Enhance Mathematics Instruction") and read chapter 7 ("Enriching Mathematics Instruction") in Teaching Secondary Mathematics. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Data Collection and Analysis

- Texas Instruments' CBL2 (Calculator-Based Laboratory)
- Texas Instruments' CBR2 (Calculator-Based Ranger)
- Fathom Dynamic Data
- Microsoft Office Online
- Microsoft Excel

There are a variety of educational technologies that can be used for data collection and analysis. In this activity, the data collection devices that you will learn how to use include Texas Instruments' CBL2 (calculator-based laboratory) and Texas Instruments' CBR (calculator-based ranger). To find out more about how to purchase these devices, go to the web resources shown above for Texas Instruments.

In this activity, the data analysis software tools that you need to learn how to use include Fathom and Microsoft Excel. To find out more about how to purchase either software tool, go to the web resources shown above.

*Note: You are not required to purchase these products, but rather, research their appropriate use in mathematics classrooms. You may want to search Google Scholar or the WGU Library for articles that reference the use of these tools in math classrooms.*

Brainstorm ways in which you can help students discover, develop, and derive the mathematical
concepts that are associated with this activity. In what ways can you help students construct their own understandings of the desired content and skills?

Think about the following:

- How do you learn how to use these data collection devices and software tools?
- Are there benefits to using such technologies?
- Can you identify several benefits?
- One of the benefits of using these technologies is that how you use them can be adapted quite easily for students with special needs or with learning style preferences. How can they be adapted?

The best way to address this question is to identify a special need or learning style preference and then make the appropriate connections.

**Performance Task 602.5.1-44**

- **Taskstream**

Follow the directions found in TaskStream in order to complete performance task 602.5.1-44. Be sure to include detailed information and respond to each prompt. The rubric by which the task will be graded is also found in TaskStream. Review it to be sure that you have included all of the relevant information required.

For this task, you will create an electronic slide presentation in which you discuss some of the technology tools available for real-world data collection and analysis.

You will need to research the classroom use of real-world data collection devices (calculator-based laboratory and calculator-based ranger) and data analysis software (Fathom or Excel). You will construct an electronic slide presentation that explains how these devices can be used to enhance the secondary mathematics curriculum.

**Dynamic Graphing Tools**

People have come a long way since the days when straightedge and compass rulers were the only tools used in a geometry class. Nowadays, there are several exciting dynamic geometry software programs available for use. These programs allow you to create geometric figures that can be rotated, stretched, shrunk, reflected, etc. Thus the objects become dynamic in the sense that they can be moved and manipulated, with the results immediately seen and available for further investigation. Why would such a program be useful? What are the potential drawbacks to allowing students to use such software?

**Competencies covered by this subject**

- **202.2.1 - Geometry (MS)**
- The graduate understands synthetic, analytic, and transformational geometries and their relationship to measurement, and understands how geometry and measurement develop from intuitive investigations to formal arguments.

- **602.5.1 - Teaching Methods-Mathematics (Secondary)**
The graduate provides effective, research-based mathematics instruction.
Data Analysis and Dynamic Graphing Tools
What are the potential benefits of using dynamic geometry software? Are there any potential issues surrounding its use? If so, what might they be? Have you ever used this sort of software? If so, was it easy to use? Did you find it difficult to learn how to use it? What are some of the major differences between the use of such software and more traditional geometry teaching methods?

After completing the following activities, you will be required to construct an original lesson plan using appropriate research-based, age-specific pedagogies for which the focus is on transforming selected geometric objects using dynamic geometry software. You will

- become familiar with a variety of dynamic software packages;
- be able to distinguish between static and dynamic geometry problems;
- use a variety of dynamic geometry software packages to create geometric objects;
- understand what it means to mathematically transform a geometric object;
- use a variety of dynamic geometry software packages to reflect, rotate, and translate geometric objects;
- be able to provide a comprehensive discussion of the instructional procedures used to engage students; and
- construct a learning environment that has students discover, develop, derive, and conceptually understand how to use selected educational technologies that explore the use of selected dynamic geometry software.

Using Technology to Enhance Mathematics Instruction

Review chapter 5 ("Using Technology to Enhance Mathematics Instruction") and read chapter 8 ("Extracurricular Activities in Mathematics") in Teaching Secondary Mathematics. Record any questions or reflections you have in your study notebook. You may also want to check the message board for this topic to see what others have posted about this. Interact with others who have posted there by answering questions or posting your own.

Note: There are 125 enrichment units for the secondary school classroom in Teaching Secondary Mathematics. It is recommended that you go to the table of contents on pages vii-viii to identify the enrichment units that are most commensurate with the requirements set forth in the upcoming performance task. A review of these units may help to stimulate ideas for the lesson plan that you need to construct for the upcoming performance task. For this section, you should focus on those units that employ technology to explore relevant topics (i.e., enrichment units 25, 111, and 114).

Static Versus Dynamic Geometry

- Geometric Shapes and Figures
- Figures and Polygons

Review the material contained in the web resources listed above covering relevant geometry topics. These web resources should provide you with an overview of the field of geometry and also basic geometric shapes. You should combine this knowledge with the terms static and
dynamic. It is recommended that you look up the terms static and dynamic in any dictionary and make the appropriate connections.

**Dynamic Geometry Software**

- Geometer's Sketchpad
- Cabri Geometry II Plus Evaluation Version Download
- Dynamic Geometry Explorations
- Teacher's TV: Using Dynamic Geometry
- National Library of Virtual Manipulatives
- Geometry (All Grade Bands)

Read the journal article listed below, available at the WGU e-reserve. Reflect upon the following questions: What is a static geometry problem? What is a dynamic geometry problem? The terms static and dynamic have very specific meanings in mathematics. You need to be clear about the specific meanings of these terms.


The web resources shown above should be helpful with making the distinction between these terms. The first site above has a free demo of Geometer's Sketchpad. The second site above provides a free demo of Cabri. Interact with the many dynamic geometry explorations linked at the "Dynamic Geometry Explorations" website. At the "Teacher's TV: Using Dynamic Geometry" website, view the "Demonstrating Dynamic Geometry" video.

There are many types of "transformations" in mathematics. The three transformations that must be explored in this activity include reflections, rotations, and translations. You should first clearly define each transformation and then be able to apply them to selected geometric objects. Conduct an Internet search for geometric transformations if you are unclear as to what is meant by this term.

The "National Library of Virtual Manipulatives" website above will provide you with a variety of interactive dynamic geometry programs that will allow you to interact with and better understand reflections, rotations, and translations. Go to the "National Library of Virtual Manipulatives" URL and scroll down the screen until you see the links entitled "Transformations-Reflection," "Transformations-Rotation," and "Transformations-Translation." These dynamic activities were constructed for pre-K-2nd graders, grades 3-5, grades 6-8, and grades 9-12. It is predicted that you will have fun with these programs. Yes, even adults can play with them.

How do you learn how to use these software programs? One way to learn how to use them is to actually "play" with them. These programs come with detailed instructions on how to use them. Once you get them downloaded, you should just play with them. The more you experiment with creating and transforming selected geometric objects, the more proficient you will become.

Brainstorm ways in which you can help students discover, develop, and derive the mathematical concepts that are associated with this activity. In what ways can you help students construct
their own understandings of the desired content and skills?

**Performance Task 602.5.1-45**

- [TaskStream](#)

For this task, you will create a lesson plan in which you teach students how to use dynamic geometry software to explore interactive geometric designs. You may use Geometer's Sketchpad or Cabri Geometry, or you may use one of the following free resources:

- [GeoGebra](#)
- [Google SketchUp](#)

**Conclusion**

Congratulations! You have completed a rigorous course of study focused on the study of selected mathematics technology topics. These topics included the pedagogy of how to teach students such varied topics as

- proofs,
- graphing calculators,
- computers,
- interactive data collection devices, and
- dynamic geometry software.

At this point, you should be commended for all of your hard work in making it this far in your program. Great job!

**Transfer and Application to Work**

How does the study of these topics apply to your profession? As a math teacher, you need to know not only the content that you will be required to teach but also how to teach that content. A greater emphasis is being placed on the appropriate use of technology in math classrooms, so it is important that you be able to do so and be able to teach your students to do the same. The activities and performance tasks found in this course of study were designed to help you develop your abilities to do all of these things.

**Next Steps**

If you have come this far in the course of study, you will have by now submitted responses to the seven performance tasks that make up the Mathematics Technology performance assessment. The full details and instructions for each of the task prompts are found in TaskStream. Your submissions will be graded, and if they are found to have met the requirements, a "Pass" will appear on your Degree Plan for the assessment. If your responses are found to need improvement, they will be returned to you for revision.

**Accessing Performance Assessments**

You should have completed the tasks as you worked through this course of study. If you have not completed the tasks in [TaskStream](#), do so now.

- MJA5
For directions on how to receive access to performance assessments, see the "Accessing Performance Assessments" page.

Feedback

To provide feedback on this or any other course of study, please use the Course of Study Feedback form.

ADA Requirements
Please review the University ADA policy.