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THE EFFECT OF USING FLIPPED CLASSROOM INSTRUCTION ON STUDENTS' ACHIEVEMENT IN THE NEW 2016 SCHOLASTIC ASSESSMENT TEST MATHEMATICS SKILLS IN THE UNITED ARAB EMIRATES

Khaled Mohammed Abdel Baki Mohammed Diab

This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Education (Curriculum and Instruction)

Under the Supervision of Dr. Adeeb Jarrah

May 2016

Declaration of Original Work

I, Khaled Mohammed Abdel Baki Mohammed Diab, the undersigned, a graduate student at the United Arab Emirates University (UAEU), and the author of this thesis entitled "*The Effect of Flipped Classroom On Students' Achievement in The New 2016 Scholastic Assessment Test Mathematics Skills in The United Arab Emirates*", hereby, solemnly declare that this thesis is my own original research work that has been done and prepared by me under the supervision of Dr. Adeeb Jarrah, in the College of Education at UAEU. This work has not previously been presented or published, or formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my thesis have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this thesis.

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Abstract

The flipped classroom instruction considered as the focus of many researchers and teachers in the recent years, many teachers around the word tried the flipped classroom instructions in different ways, different tools, to teach different subjects with different grades. Taking in the consideration, applying the flipped classroom teaching methods needs a lot of preparation and technological tools. This study utilized a quasi-experimental method research design to investigate the effect of flipped classroom instruction on students' achievements in the new SAT 2016 mathematics skills (Heart of Algebra, Problem solving and data analysis, and Passport to Advanced Math) for the eleventh grade Emirati, female students in Al Ain, United Arab Emirates. The purpose of this study was to determine if there was a statistically significant difference in student achievements in the new SAT mathematics skills between two groups of grade 11 students, the experimental group was taught by flipped classroom instruction, and the control group was taught by ordinary teaching methods. The result of the posttest showed a statistically significant point of preference for the experimental group over the control group in all of the new SAT mathematics skills except the problem solving and data analysis skills. Finally, study findings suggest that teachers who are teaching mathematics standardized test skills like SAT may use flipped classroom instruction to increase the students' readiness and to improve the students' thinking skills to simulate the 21st-century skills. After offering a proper training and professional development courses in the best practice of flipped classroom instruction.

Keywords: Flipped Classroom instruction, Ordinary classroom, SAT.

Title and Abstract (in Arabic)

تأثير طريقة الصف المقلوب على تحصيل الطلبة في مهارات اختبار

(New SAT 2016) للرياضيات في دولة الإمارات العربية المتحدة

الملخص

تعتبر طريقة الصف المقلوب محور اهتمام الكثير من الباحثين والمعلمين في الآونة الأخيرة. فالكثير من المعلمين قاموا باستخدام طريقة الصف المقلوب بطرق مختلفة من خلال العديد من وسائل التكنولوجيا الحديثة ، وذلك لتدريس مواد عده لمراحل دراسية متباينة حيث أن استخدام طريقة الصف المقلوب تتطلب الكثير من التحضيرات المسبقة واستخدام وسائل تكنولوجيا تعليمية عديدة. ولقد تم استخدام المنهج شبه التجريبي للتحقق من تأثير استخدام طريقة الصف المقلوب على تحصيل الطلبة في مهارات اختبارات (New SAT) للرياضيات (الجبر – حل المشكلات و تحليل البيانات – الجبر المتقدم). وذلك للطالبات الامارتيات في الصف الحادي عشر بمدينة العين – دولة الامارات العربية المتحدة. وقد هدفت الدراسة لمعرفة الفروق ذات الدلالة الإحصائية بين مجموعتين من الصف الحادي عشر ـ المجموعة الأولى (المجموعة التجريبية) وقد تم تدريسها بطريقة الصف المقلوب، والمجموعة الثانية (المجموعة الضابطة) والتي تم تدريسها بالطريقة العادية. ولقد أظهرت نتائج الاختبار البعدي وجود فروق ذات دلالة إحصائية لصالح المجموعة التجريبية على حساب المجموعة الضابطة في جميع مهارات الرياضيات الخاصة باختبار ال (New SAT) ماعدا المهارات الخاصة بحل المشكلات وتحليل البيانات .وبناء على نتائج الدراسة، فقد اقترح الباحث ان يقوم المدرسين المسئولين عن إعداد الطلبة للاختبارات الدولية المعروفة كاختبارات (New SAT) بالاستفادة من طريقة الصف المقلوب في زيادة جاهزية الطلبة للاختبارات بالإضافة الى تطوير مهارات التفكير لدى الطلبة وذلك لمحاكاة مهارات القرن الواحد والعشرون. وذلك بعد تدريب المدرسين واعدادهم لاستخدام أفضل الطرق والممارسات في استخدام طريقة الصف المقلوب في التدريس.

مفاهيم البحث الرئيسية: طريقة الصف المقلوب، الطريقة العادية في التدريس،SAT .

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Dedication

To my beloved parents and family

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List of Abbreviations

SAT   Scholastic Assessment Test

PISA   Program for International Students Assessment

ATHS   Applied Technology High School

Chapter 1: Introduction

Recently there is a great challenge to educators; they need to keep up with the 21st-century skills, creativity, critical thinking, communication, and collaboration are essential to prepare students for the future (Perry, 2012). Teaching Mathematics concepts in general, and standardized tests skills, in particular, need a lot of efforts and many useful activities to enhance student learning. During the teaching time, Some challenges will face the educators like, student's needs, and students' abilities, for example, some students need a lot of effort to understand the math concepts. This difficulties in understanding may be because students' abilities are different, some students are missing their classes for different reasons. All of these factors will affect students' performance inside the classroom or at home. Solving Mathematics homework is one of the critical issues in education. If students' understanding is not clear inside the class, they will face some difficulties in doing their homework. They will stick to some questions, and they will wait for the next class. In this case, the teacher will use the next class time for solving the homework, or he will ignore the homework explanation. From, my experience as a math teacher, this type of students needs an extra time during the break time or after school might help instead of losing the class time. So the main point here is, how to use the face to face time effectively? And how we offer an effective support to our students in their homework and practicing for the standardized exams? Teachers should use a variety of the new teaching methods to meet the student's needs. One of the new teaching methods in the education field, can be used to meet every student every time, is called flipped classroom, by moving the lecture outside the classroom via technology and moving homework and exercises with concepts inside the classroom via learning activities (Bergmann & Sams, 2012; Brunsell & Horejsi, 2011; Tucker, 2012; Young, 2011).

The use of technology is a must in applying flipped classroom instruction, where the computer takes over the task of providing the lecture content so that class time can be spent actively using the content being learned. A podcast is created by the instructor or students to deliver, for example, the science content. Podcasting refers to the "distribution of audio/video files in digital format" (McGarr, 2009, p. 309). The podcast is then downloaded and distributed via the internet to people who subscribe to the feed Using the internet to provide podcast lectures of class lessons has a two-sided benefit for students. It allows some students who were absent from class due to illness, sports or many other reasons, a way to stay caught up with the class. The podcast also allows a student to watch the lecture as many times as needed. In a study done with 40 undergraduate general psychology students, a lecture setting using a speaker, PowerPoint slides, and handouts was compared with a podcast setting of the same lecture and PowerPoint handouts. According to this study, the students in the lecture setting could never go back and hear the lecture again, but the students in the podcast setting, even though they were not given specific instructions to do so, went back and watched the lecture multiple times. Heilesen (2010) presented a paper reviewing scholarly literature published between 2004 and 2009 on experiences with podcasting and education. He found that listening repeatedly to a lecture by way of a podcast helped the listener understand more of what was said, a speculation can be made about podcasting and improved study environments. He believes that because students see the use of podcasting as a tool to improve their study environment, students will not need to spend as much time completing the course of study and therefore will tend to finish the course and perhaps finish on a higher academic level (Heilesen, 2010).

When less time is needed to study the material, students tend to follow through and put the time in to get the concepts understood. Flipping the classroom has changed

the teacher's role. They will not stand in front of the students and lecture for forty-five to sixty minutes at a time. The most significant benefits of using flipped classroom instruction in teaching, is the increasing in the class interaction: Teacher to student and student to student. Since the role of the teacher has changed from the presenter of content to learning coach, Teachers spend the class time talking to students. The teacher is answering questions, working with small groups, and guiding learning of each student individually. When students are working on an assignment, they notice a group of students who are struggling with the same thing, the teacher automatically organize the students into a tutorial group. Since the role of the teacher has changed, to more of a tutor than a deliverer of content. Students are working collaboratively to achieve their learning outcomes, and they will not rely on the teacher as the main resource of knowledge.

In the school where the researcher was conducting the study, the high expectations and teaching time were the main two factors cause a lot of pressures and stress in teaching and preparing students for the standardized test like SAT, especially the new designed SAT (new SAT 2016). So students should have trained very well in a shorter period, another teaching method is needed to support students in their standardized tests. Flipped classroom was the alternative teaching method, where it is allowed the use of class time in interacting and solving a higher level of SAT questions. By using flipped classroom instruction in teaching math, the lower order thinking skills will be at home through learning videos, and the higher order thinking skills will take a place inside the classroom (Bergmann, 2013).

1.1 The Redesigned SAT 2016

Starting from March, 2016 college board began a new version of SAT exam, which is designed with no more tricks, and it is focused in real math skills, like algebra, data analysis, problem solving, and a complex connection. The new SAT designed to measure the students' college readiness, and to give the students the opportunities to show what they have learned in the school. The new SAT math test is consisting of two sections, the first section includes 20 questions in 25 minutes, students in this section are not allowed to use calculator, the second section includes 38 questions in 55 minutes, students in section 2 can use calculator. The total number of questions in the two sections is 58 questions, distributed as; 19 questions in Heart of Algebra skills, 17 questions in Problem solving and Data Analysis skills, 16 questions in Passport to Advanced Algebra skills, and 6 questions in additional topics in math (College Board, 2016). The new SAT test questions are designed to relate math with instruction in science, social studies, and career related courses. The new SAT math test specifications is totally different than the old version of SAT test (see appendix A).

1.1.1 New SAT Heart of Algebra skills

Algebra considered as the language of mathematics in high school education system. It is the base of the high school mathematics pyramid, without mastering algebra students cannot understand advanced math or calculus. For example, without mastering linear equations, students cannot understand how to determine the best linear approximation of nonlinear functions, using differentiation in calculus As mentioned above, the number of questions assigned to test the Heart of Algebra skills in any new SAT test is 19 questions, those questions have designed to test the student's knowledge in analyzing and fluently solving linear equations and systems of equations, creating linear equations and inequalities to represent relationships between quantities

and to solve problems, understanding and using the relationship between linear equations and inequalities and their graphs to solve problems. Those concepts already taught to students in grade 7, 8, and 9 (Algebra 1) course (Common Core State Standards for Mathematics, 2010).

1.1.2 New SAT Problem Solving and Data Analysis skills

Before doing a new SAT test, students should master the main skills in problem solving and Data analysis like; Creating and analyzing relationships using ratios, proportional relationships, percentage, and units, representing and analyzing quantitative data, and finding and applying probabilities in context. Mastering the problem solving and data analysis skills need, the ability of solving real word problems, and analyzing data. In problem solving questions, students should know how to answer more than one question, for the given situation (College Board, 2015).

1.1.3 Passport to Advanced Math

The third main part in the new SAT skills is the advanced math concepts, like identifying and creating equivalent algebraic expressions, creating, analyzing, and fluently solving quadratic and other nonlinear equations, and creating, using, and graphing exponential, quadratic, and other nonlinear functions. (College Board, 2015). New SAT test will cover those skills in 16 questions in any SAT test. Students already taught those skills in grade 10 and 11 (Algebra 2) course (Common Core State Standards for Mathematics, 2010).

1.2 United Arab Emirates Context

The United Arab Emirates, one of the leading countries in the use of technology in education. In April 2012, Mohammed Bin Rashid Smart Learning Program have been launched by His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai. This program is aligned with UAE vision 2021 to become a knowledge-based economy through the integration of technology in education. The main goal of MBRSLP is, to create a new learning environment with smart classrooms, offering new teaching methods through the integration of technology in the education system. Furthermore, smart education will involve students in the learning process inside the classroom and outside. (Mohammed Bin Rashid Smart Learning Program, 2012).

Moving from the use of smart learning in general in the context of UAE, to the use of flipped classroom instruction in particular. In the 2012 -2013 academic year, English teachers from Higher College of technology (HCT) in UAE used the flipped classroom instruction, in teaching the foundation level 03 students. They created video modules teaching 10 or 11 words, by the average of three modules every week. And according to their personal feedback, they found using the flipped classroom instruction in teaching the foundation courses, had a positive impact on students (Fallows,2013).

In April, 2015 HCT organized the 3rd Annual Mobile Learning Conference, under the theme of Toward a Smarter City, which focused on learning and society. At the first day of the conference, one of the speakers was, Jon Bergmann, Chief Learning Officer of Flippedclass.com, who is considered one of the pioneers in the Flipped Class movement and is a co-founder of The Flipped Learning Network. He spoke about the

best use of face – to face time, and he explained many benefits of using flipped classroom in teaching, especially for the university students level (HCT, 2015).

1.3 Statement of the Problem

In many schools in the United Arab Emirates, including the research site for this study, students are facing difficulties in understanding Math skills and especially when they need to practice for the standardized test like SAT, Which is covering many domains in Mathematics like (algebra – geometry – data analysis- trigonometry). SAT is considered as one of the graduation requirements for students participating in this study Which requires, the intensification of ongoing training on the SAT skills. Taking in the consideration, teachers should teach algebra 2 curriculum and SAT skills in seven periods only per week. Teaching the new SAT skills, Which simulates the 21st-century skills needs to reinforce on many Mathematics skills like algebra 1 and geometry curruculums. The study problem is to investigate the effect of flipped classroom instruction on the eleventh grade Emirati female student's achievement in the New SAT Assessment test mathematics skills in one of the government school in Al Ain, United Arab Emirates.

1.4 Purpose of the Study

The purpose of this study is to figure out if there are a statistical difference between the achievements of the students in the new SAT overall score. In addition to that , to figure out if there is a statistical difference in the score of the main three SAT skills in the new SAT, (Heart of Algebra, Problem Solving, and Data Analysis, and Passport to Advanced Math) between the two groups of eleventh-grade students, who taught by flipped classroom instruction and who is not.

1.5 Research Questions

This research investigated if the flipped classroom instruction helped grade 11 students to achieve better than an ordinary classroom in the new SAT skills. Through the answers of the following research questions:

- Is there any significant difference in the New SAT achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

- Is there any significant difference in the New SAT- HEART OF ALGEBRA skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

- Is there any significant difference in the New SAT- PROBLEM-SOLVING AND DATA ANALYSIS skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

- Is there any significant difference in the New SAT- PASSPORT TO ADVANCED MATH skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

1.6 Significance of the Study

Ministry of Education in the United Arab Emirates strategy plan 2010-2020 included in the strategic initiatives part, developing a proposal of eliminating the foundation courses in the universities, by closing the gap between the higher education system and university system. By assessing the skills need a developing in higher education system. (Ministry of Education, 2010). Investigating the effect of flipped

classroom instruction in teaching the new SAT skills, may help to increase the students' college readiness.

Many schools in the United Arab Emirates including the research site, who are following the common core standards; providing their students by SAT exam preparation courses in Mathematics skills. In the research site, students used to start SAT training lessons from grade 11. There are a specific lesson and time for teaching SAT skills.On the other hand, there are many lessons should be covered in parallel with SAT lessons. Using flipped classroom instructions in teaching SAT exam skills may help teachers to reduce lecturing time, and increase guides time, in other word using flipped classroom instruction in teaching, will save a lot of class time to improve the students' critical thinking and problem solving skills through collaboration with their colleagues and teacher. This study can be the base of the new system of international exams training courses in the United Arab Emirates, which will encourage students to be involved in the process of learning. This study is significant as there are no published studies related to the new SAT skills in the United Arab Emirates, and few studies in flipped classroom instruction as well. The results of the study may help teachers in using the best practice of flipped classroom in teaching.

Data and results of this study may guide teachers to the situation of student's level in the new SAT skills, and which skill exactly needs extra time and effort. Finally, findings of this study may help curriculum developers in UAE in planning.

1.7 Definition of Terms

- The flipped classroom instruction: It is a relatively new teaching strategy attempting to improve student engagement and performance by moving the lecture outside the classroom via technology and moving homework and

exercises with concepts inside the classroom via learning activities (Bergmann & Sams, 2012)

- Ordinary Classroom: An instructional setting in which students receive instruction from a teacher during class time, tend to be passive recipients of knowledge (Lave, 1988), and practice or another supplemental work is assigned to be completed by the student at home.

- SAT: The SAT is a standardized test administered by the College Board, a non-profit organization that runs other programs, originally stood for the Scholastic Aptitude Test. SAT as the most widely used college admissions entrance exam. In response to both its loss of market share and criticisms about the very substance of the exam, the SAT is launching an entirely redesigned exam in the spring of 2016 (College Board, 2016).

1.8 Limitations

During the implementation of the study, some factors considered as a cause of limitation of the study. First, the sample of the study was 79 Emirati female students, the control group (N= 40) and experimental group (N= 39) was found to limit the findings and the result couldn't be generalized. The second limitation was the gender that could have impacted the results of the study. The study was conducted on female students, but may be conducting the study on male students would have given varied results. The third limitation was the lack of research related to the flipped classroom in the United Arab Emirates. Finally, the study is conducted using a standardized test (the New SAT). Which the result focused only on the new SAT skills.

1.9 Delimitations

The study was restricted to the HST, and AE students only, who were taught by the researcher, the second delimitation was the study duration (six weeks), which is not enough to guaranty a good practice for the new SAT skills. Finally, the study was implemented by one teacher who also was the researcher. Conducting the study by different or more teachers might not yield the same result.

Chapter 2: Literature Review

2.1 Overview

This literature review spots the light on the theoretical framework of the current study. Vygotsky's social constructivism theory and Bandura's Social Learning Theory are discussed, as well as Blooms Taxonomy. An overview of some previous studies regarding the flipped classroom in is demonstrated, followed by the chapter summary.

2.2 Theoretical Framework

The use of flipped classroom instruction in teaching can be framed by the constructivism theory when teaching new math concepts, since the study conducted in teaching the new SAT skills, which need more interaction between students, to exchange their knowledge and skills. The Vygotsky's and Bandura's theories were utilized to explain the relationship between the flipped classroom instruction, and academic achievement in the new SAT skills. In addition to that, Blooms Taxonomy thinking skills are obvious in the flipped classroom, since teaching SAT skills by flipped classroom instruction saved the face to face time for higher order thinking skills, and sending the lower order thinking skills home via video lectures.

2.2.1 Vygotsky's Social Constructivism Theory

Vygotsky recommended that students obtained a new knowledge through social interaction with others. By supporting learners to scaffold their learning, and providing them with suitable activities (Saunders, 2014). This scaffolding learning is showed clearly with flipped classroom students, by using the class time to increase the level of difficulty, and to improve the student's thinking skills. Previously, the teacher was the unique resource of delivering Mathematics concepts. Recently, teaching

instructions focused on the cooperative learning and its effect on student's performance, the teachers and peer's role have been improved and became more active (Stallworth, 1995). Vygotsky stressed the importance of the experimental learning; teachers should encourage students to exchange their internal and external knowledge. Teacher role should be as a facilitator of the learning process. By using modeling and scaffolding techniques (Gultekin, 2006). This scaffolding technique is implemented in flipped classroom instruction in each lesson, since the teacher is providing students with metacognitive support, to ensure that students are responsible for their learning (Bergmann & Sams, 2012b; Johnson & Renner, 2012).

When Vygotsky's social constructivism theory used in the mathematics classroom, taking in the consideration, the teacher is a facilitator and technology used effectively in learning. Students acquired mathematics skills faster and kept mathematical information longer. Even their mathematics achievement was improved (Jones, Jones, & Vermette, 2010).

2.2.2 Bandura's Social Learning Theory

Bandura's Social Learning Theory provided another theoretical framework for the use of flipped classroom instruction in teaching. Social learning theory shows the effectiveness of the environmental and cognitive factors interact to shape the learning and behavior. Students can learn from each other, by modeling, and observe (Abbott, 2007). Students in flipped classroom, acquired learning after seeing lessons through videos, according to Miller (2011), "Older children, by observing a model, are expected to learn complex new skills quickly, with a minimum of verbal instruction" (p. 251). So in flipped classroom instruction, the social learning theory of Bandura was

clearly displayed, since effective modeling of concepts is presented (via online videos (Khan Academy new SAT training course videos, and teacher-made videos).

2.2.3 Blooms Taxonomy

Teachers used to apply Blooms Taxonomy in teaching; many ordinary classes started and ended by the lower order thinking skills in Blooms taxonomy. Using flipped classroom instruction gave the educator the chance to decrease the lecturing time and increase the interaction time with the students, to improve their thinking skills. Students in flipped classroom instruction had the opportunity to think deeply and creatively. Bergmann (2013) believes that the one emphasis of the flipped classroom lies in inverting Bloom's taxonomy so that students have the opportunity to apply and maximize interactions between student and instructor and student and peer. The teacher is then there to support and guide students through the higher- order thinking skills of applying, analyzing, evaluating, and creating in the classroom (Hamden, McKnight, McKnight & Arfstrom,2013).

Bloom's taxonomy is an education tool that helps educators to increase the learning level and to improve the student's thinking skills. The use of Bloom's taxonomy has been shown to enhance student mastery of concepts and critical thinking skills (Bissell & Lemons, 2006). Anderson and Krathwohl (2001) renamed the levels to fit the 21st-century student naming them as remember, understand, apply, analyze, evaluate, and create.

Bergmann and Sams (2012) suggest that the higher-order thinking skills must be completed in the classroom where they have instant access to teachers. Bergmann and Sams (2012) stated: The time when students need me physically present is when they get stuck and need my individual help. They do not need me there in the room

with them to yak at them and give them content; they can receive content on their own. (pp. 4-5).

Bergmann and Sams (2012) figured out when Blooms taxonomy was inverted; students were able to think more, and the learning skills inside the classroom were changed to the higher order thinking skills of applying, analyzing, evaluating, and creating instead of only having students learn at the lowest levels, remembering and understanding. This improvement in thinking skills because of the changes in the teacher's role. Moreover, the lowest level of Blooms taxonomy (remembering and understanding of content) were taught by flipped classroom at home, to save the class time (face to face time) in higher order thinking skills. Bergmann and Sams (2012) figure out that many students forget what the teacher has said during the lecture. Moreover, they will not be able to do their homework without any help. In a flipped classroom, Bloom's levels of remembering and understanding are now given to students before class at home via lectures using YouTube teaching videos or similar technology (Bergmann, 2013). Bergmann and Sams (2012).

Bergmann (2013) suggested teachers should shift the higher order thinking skills to the classroom by inverting Bloom's taxonomy (see figure 1). If educators invert Bloom's taxonomy and shift the lower levels of remembering and understanding out of the classroom by using technology piece, then students can apply those higher-order thinking skills of applying, analyzing, evaluating, and creating in the classroom with teacher and peer support (Sams & Bergmann, 2013).
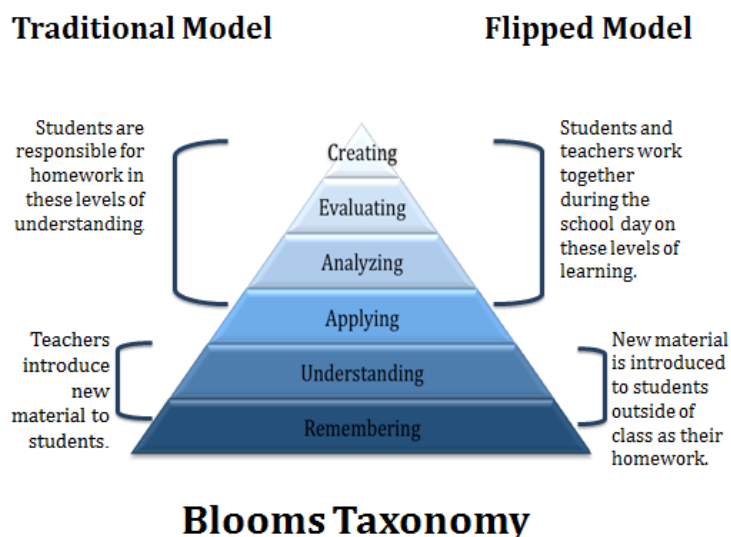
Traditional Model   **Flipped Model**

Students are
responsible for
homework in
these levels of
understanding

Creating

Evaluating

Analyzing

Applying

Understanding

Remembering

Students and
teachers work
together
during the
school day on
these levels of
learning.

Teachers
introduce
new
material to
students.

New material
is introduced
to students
outside of
class as their
homework.

Blooms Taxonomy

Figure 1: Bloom's Taxonomy in Flipped Classroom, (Williams, Beth, 2013)

2.3 History of Flipped Classroom

The beginning of teachers thinks about the inverted classroom dating back to the late 1990s (Baker, 2000). However, there were a less amount of studies that related to the Flipped Classroom. This lack of information may because of the lake of technological tools in education that needed to apply flipped classroom instruction until the last few years. S. In 1920s radio and televisions could be used to deliver the content, that method was called distance learning not flipped classroom (Byrne, 1989). In the 1960s The Open University was the first university in the United Kingdom applied a daily distance education television program seen early mornings throughout the United Kingdom, Canada, and Australia (The Open University, 2014).

The flipped classroom instruction is all most a new teaching method, trying to engage students in the learning process. By moving the lecture outside the classroom, via technology and moving homework into the classroom, via learning activities (Bergmann & Sams, 2012).

The new generation of flipped classroom with online videos followed by the face-to-face instruction is often credited to Bergmann and Sams (Pink, 2010). In 2007, they were both science teachers at Woodland Park High School in Colorado. Some critical reasons like the remote location of their school increased the number of absent students in their school, and they were finding that many students needed to leave early in the day to attend athletic events or other school related activities. Bergmann states that the early recordings were only for students who missed class (Bergmann & Sams, 2012a).

In March of 2011, Salman Khan used the term "flipping the classroom" in his TED talk (Khan, 2011). Salman Khan has endorsed the flipped model and has stated that his videos allow the teacher to focus on higher-level learning activities, such running simulations, and labs with students, doing individual interventions and facilitating peer-to-peer learning (Fink, 2011; Gojak, 2012). From that date, interest in the flipped classroom instruction has grown exponentially with new articles, and blogs on the flipped classroom teaching method.

2.4 Impact of Flipped Classroom Instruction on the Students' Achievement in Mathematics

In spite of the spread of the flipped classroom instruction around the world, but there are few studies show a positive impact of using flipped classroom instruction on the achievement of the students in mathematics.

Love, Hodge, Grandgenett, & Swift (2013) conducted a study focused on the achievements of the students taught by two different methods (flipped classroom and ordinary classroom), the course, was linear algebra taught by the same teacher. 55 students participated in the study 27 were in the flipped classroom and 28 in the

ordinary classroom. Each of the two sections met for two 75-minute classes each week. The study compared between a section of linear algebra taught in the ordinary lecture style, with a section of linear algebra taught in a flipped model (Love, Hodge, Grandgenett, & Swift, 2013). The only analysis was that the performance on the second exam relative to the first exam, the average change in score for the students in the flipped section was significantly greater than for those in the ordinary section ($p <$ 0.034). When comparing the third exam to the first exam, the average change in score for those in the flipped classroom section was again significantly greater than for those in the ordinary section ($p < 0.012$).

Another study took place at a medium-sized private university in the southern United States in 2015. Students taught Calculus III in two semesters fall, and spring, by two different teaching methods, ordinary teaching and flipped classroom teaching method. Participants in the study were 41 students taught by ordinary teaching methods and 39 students taught by flipped classroom instruction in the fall semester. In the spring semester, the number of students in the control group decreased to 36, and the number of students in the experimental group, decreased to 35. The result of Quint study showed, the use of flipped classroom teaching method increased student learning during the second semester of the study. This result showed that the second time of using flipped classroom instruction in the spring semester, was more effective at preparing students for exams than the first time in the fall semester (Quint, 2015).

On the other hand, study conducted by Martin (2015), about the impact of flipped classroom instruction on middle school mathematics achievement. The participants of the study were grade 8 students at one of the suburban independent school district in Texas. A total of 503 students instructed in the flipped classroom instruction, and a total of 522 ordinary classroom students. The result of the study

showed that, there was no significant difference between the scores of students in pre-AP and regular mathematics classes receiving instruction in the flipped classroom and the scores of students in pre-AP and regular mathematics classes receiving instruction in the traditional classroom (Martin, 2015).

2.5 Studies Related to the UAE and the Regional Context

Study done by Mireille Farah (2014) in the Applied Technology High School (ATHS) in United Arab Emirates, to examine the impact of using flipped classroom instruction on the writing performance of Twelfth grade female Emirati students in the applied technology high school (ATHS), The main objective of the study was to measure whether there is any significant differences in the writing attainment of students who learn through the flipped classroom instruction method and those who learn ordinary. The study also sought to identify female students' perception of the Flipped Instruction in an ESL writing setting through a fifteen-week teaching program. Findings revealed statistically significant differences between the mean scores in favor of the students in the experimental group. Furthermore, the results showed that this improvement in the writing performance is largely attributable to the Flipped Instruction method of teaching. Students' attitudes towards the Flipped Instruction proved to be equally favorable (Farah, 2015).

A study was done in Saudi Arabia, focused on the impact of using flipped classroom instruction on the promotion of students' creative thinking. Participants were from the Faculty of Education at King Abdulaziz University in the first semester of 2014. The total number of students, who participated in the study was 55 students; 28 students taught by ordinary teaching method, and 27 students taught by flipped classroom instruction. The findings of the study suggested that the flipped classroom may promote students' creativity, Data in total creativity: the flipped classroom scores

(M = 17.44, SD = 3.78) were higher than the ordinary classroom scores (M = 12.43, SD = 4.65; t [53] = −4.38, p = .000) (Al-Zahrani, 2015).

Another study, conducted at Qatar University as a pilot study in the spring semester of the academic year 2014. 40 female students in pre-calculus foundation course have participated in the study. The duration of the study was two weeks. Students taught three sections from the syllabus, covering inverse functions, exponential functions, and logarithmic functions. Teacher used videos from Khan Academy and Tv sites in teaching the three lessons. After two weeks of teaching by flipped classroom instruction, students took a quiz. The result of the quiz compared with, the result of two quizzes done before the implementation of flipped classroom instruction. The result of the study showed the results of the students in quiz 3 using the flipped classroom method is better than the first two quizzes (Syam, 2014).

2.6 Studies in Flipped Classroom Related to Different Subjects

Zappe, S. Leicht, R., Messner, J., Litzinger, T. & Lee, H. (2009) and Pierce, R. (2012) used a flipped classroom instruction in an Undergraduate Architectural Engineering Course and a Renal Pharmacotherapy Module, respectively. Both studies found positive implications of the teaching approach on students' learning and improved performance.

Ruddick (2012) used the flipped classroom instruction teaching one of her chemistry courses. Students taught by flipped classroom instruction were able to watch the lesson via the teacher made videos at home and spent class time working on the classroom activities. Final exam scores compared to the students in the flipped classroom and those in the ordinary classroom setting. The results showed that the flipped students did better than the ordinary (lecture) students with higher final exam scores and overall success in the class.

On the other hand, Johnson and Renner (2012) did a study on the effect of the flipped classroom model on a secondary computer applications course in a high school setting in Kentucky during the 2010-2011 school year. The study duration was six weeks among two groups, one group taught by flipped classroom instruction and the other one taught by ordinary classroom instructions. The results of a *t*-test comparing the post-test scores of students who did and did not participate in the flipped Excel unit found no significant difference. (Johnson and Renner, 2012).

2.7 Summary

The review of literature reported different impacts of using flipped classroom instruction in teaching. Studies like; (Love et al (2013), (Quint, 2015), (Farah, 2015), (Al-Zahrani, 2015), (Syam, 2014), Zappe et al. (2009) and Pierce, R. (2012), showed that there was a positive impact on students' achievement when students taught by flipped classroom instruction. On the other side, studies like; Martin (2015), and Johnson and Renner (2012) showed that, using flipped classroom instruction in teaching, had no impact on the students' achievements. As a result of the previse studies conducted in flipped classroom instruction. There are a variety of the results when flipped classroom instruction used as a teaching method; few studies have been conducted in the UAE context, and no studies conducted in the use of flipped classroom instructions, as teaching method for international exams, like SAT.

Chapter 3: Methods

3.1 Overview

The aim of this study is to investigate the effect of flipped classroom instruction on the eleventh grade Emirati female students' achievement in the New SAT Assessment test mathematics skills in one of the government school in Al Ain, United Arab Emirates.

The study has been done in the second term of the academic year 2015-2016 with the total number of six teaching weeks. The New SAT skills have been taught to a total of 79 female students in grade 11, students who were enrolled in The New SAT training courses. The participants in the study were divided into two groups. (1) The experimental group: 39 students and (2) the control group: 40 students, Independent variable, was the teaching instruction. On the other hand, the dependent variables were the New SAT overall score, and the score of the three skills, the heart of algebra in the New SAT skill score, the problem solving and data analysis in the New SAT skill score and the passport to the advanced math in the New SAT skill score. Taking into consideration, all students had their laptops and iPads as learning tool in both approaches. In this chapter, the research design is discussed in detail, including the research method used, the research setting, participants of the study, the procedures of the study and the data sources collected and analyzed.

3.2 Research design

This study used a quantitative quasi-experimental design to investigate the effect of using flipped classroom instruction in teaching the New SAT Mathematics skills, which the participants were divided into two groups:

- The experimental group (1): students taught the New SAT skills using the flipped classroom instruction, (N= 39) contains classes B and D.

- The control group (2): students taught the New SAT skills using the ordinary teaching methods, (N=40) contains classes A and C.

A pretest (New SAT Practice test) was given to the two groups to test the equivalency between the two groups before starting the study. After six weeks, the posttest (new version of the New SAT practice test) was given to the two groups, in order to compare between the achievements of the two groups after the implementation of the flipped classroom instruction.

3.3 Participants

The research site in this study is a technical high school in Al Ain serving approximately 887 students and include students in grade 8-12. Participants were seventy-nine eleventh-grade female students. The students at the Applied Technology High School where the study took place are divided into different scientific clusters, i.e. Engineering Sciences (ES), Health Science and Technology(HST), and Applied Engineering(AE). Seventy-Nine students taught by the same teacher, who were divided into two groups; experimental group (Group 1) and control group (Group 2). The control and experimental classes that participated in the study were academically and demographically equivalent; each group contains one class from HST cluster and another class from AE cluster, in addition to that all students have the same nationality and same gender (Emirati female Students), as shown in table 1.

Table 1: Number of students per section, and type of cluster

Section	Number of students	Cluster
Section A	23	Applied Engineering
Section B	21	Applied Engineering
Section C	17	Health Science and Technology
Section D	18	Health Science and Technology
Total	79	

As shown above the sampling consists of two different clusters, students who are in the first cluster; Applied Engineering cluster are studying different types of courses in grade 11 like, Computer Aided Drafting, Electrical Principles and Applications, Pneumatics and Hydraulics, and Fundamentals and Applications of PLC. The outcome benchmark for this cluster consists of, IELTS 6.0, IC3, and SAT Reasoning (Math). The students who are in the second cluster; Health Science and Technology cluster are studying different types of courses in grade 11 like, Biology 1and 2, Human Health1 and 2, and Health Care. The outcome benchmark for this cluster consists of, IELTS 6.0, IC3, AP Biology and SAT Reasoning (Math). In addition to that they are studying Math, Arabic, English, and Islamic. Based on that, SAT is one of the requirements of AE and HST cluster, that requires a lot of ongoing training on SAT skills.

3.4 Instruments

To attain the aims of the study, the instruments utilized in this quantitative quasi-experimental study were a pre- and posttest, with the evaluation instrument

(new SAT test answer key). Learning material like online videos created by the teacher, was also designed and reviewd.

3.4.1 Pretest

In order to verify the equivalence of the two groups, the experimental group and control group before conducting the study, the two groups were given a pretest in new SAT math skills provided by college board, the test consists of two sections; the first section contains 20 questions in 25 minutes, included the heart of algebra skills and passport to advanced math skills. The second section contains 38 questions in 55 minutes, included the heart of algebra skills, problem solving and data analysis skills, and passport of advanced math skills. the first section of the exam, students were not allowed to use the calculator as a new instructions of the new SAT exam, but in the second exam they were allowed to use calculator. The evaluation of the pretest done through the provided model answer. The pretest questions distribution is presented in table 2.

Table 2: The New SAT Pretest Questions Distribution

Sections /skills	Heart of Algebra	Pproblem Solving and Data Analysis	Passport to Advanced Math
Section 1 (No Calculator)	Questions 1-3; 6; 8-9; 16; 20	No Questions	Questions 4-5; 7; 10;12-15; 17
Section 1 (Calculator)	Questions 1; 3; 6; 8-9; 12; 21; 25; 28; 34-35	Questions 2; 4-5; 11; 13-20; 27; 31-32; 37-38	Questions 7; 10; 22-23; 26; 29; 33

3.4.2 Posttest (Achievement Test)

After six weeks of teaching two different groups the new SAT skills, one group taught by flipped classroom instruction, and the other group taught by ordinary teaching methods. The two groups were given a Posttest in new SAT math skills provided by college board, the test consists of two sections; the first section contains 20 questions in 25 minutes, included the heart of algebra skills and passport to advanced math skills. The second section contains 38 questions in 55 minutes, included the heart of algebra skills, problem solving and data analysis skills, and passport of advanced math skills. the first section of the exam, students were not allowed to use the calculator as a new instructions of the new SAT exam, but in the second section they were allowed to use calculator. The evaluation of the posttest done through the provided model answer. The posttest questions distribution is presented in table 3.

Table 3: The New SAT Posttest Questions Distribution

Sections /skills	Heart of Algebra	Pproblem Solving and Data Analysis	Passport to Advanced Math
Section 1 (No Calculator)	Questions 1-3; 7-8; 12; 19-20	No Questions	Questions 4-6; 9-11; 13; 15; 18
Section 1 (Calculator)	Questions 1-2; 6; 8; 16-17; 19; 26; 29; 32; 34	Questions 3-5; 7; 9-11; 13-15; 20-23; 27; 31; 33	Questions 12; 25; 28; 30; 35; 37-38

3.5 Test Validity

To test the validity of the new SAT test, content related validity used as an evidence of the test validity. According to Popham (2014), content validity means "the extent to which an assessment procedure adequately represents the content of the curricular aim being measured" (P.103). As stated above, the new SAT test consist of

58 questions, and since the new SAT test is provided by College Board, the college Board development committees, experienced educator and subject matter experts reviewed the new SAT test content. In addition to that, the test reviewed by a group of Math teachers in the study site, who are experts in international exams like, SAT, SAT subject, and AP. The second type of validity evidence used in the study was, criterion related validity. Since SAT exam is taking by more than 2 million students in 190 countries, which is accepted by more than 2000 colleges and Universities. The SAT is valid to predict students' grade point average and course grades of college freshmen. The College Board (2006b) stated, "The SAT gives colleges a more objective way to evaluate what students know and can do. As the SAT is one of the most well-known and visible standardized tests in the world. Participants become more experienced over time. SAT questions testing the student's skills in the enrolled courses (algebra I, geometry, algebra II). The new test design is based on the most current national and international research on the skills and knowledge needed for success in college and career. Each academic year, millions of students take the SAT at more than 7,000 test centers in more than 180 countries. Nearly all four-year colleges and universities in the U.S., including test-optional institutions, use SAT scores because the SAT is a reliable measure of college readiness as well as a fair and valid indicator of likely success in college and career training for students from all backgrounds.(The College Board 2015). For the redesigned SAT (New SAT 2016) , The predictive validity of the exam , its ability to estimate the likelihood of success in postsecondary education , is what makes the exam a valuable part of the admission process in colleges and universities. The sat has been redesigned to maintain if not strengthen this predictive validity while accomplishing other aims, such as offering greater insight into student performance (The College Board 2015).

3.6 Test Reliability

Test considered as a reliable test if the test items measures what it is supposed to measure. Internal consistency reliability presents the degree of which each part in the test is measuring in a consistent way (Popham, 2014). Reliability analysis was conducted on the test items, and the results were as shown in table 4.

Table 4: Cronbach's Alpha Coefficients for Subsets and Total Test Items

Skill	Cronbach's Alpha
Heart of Algebra	.63
Problem Solving and Data Analysis	.58
Passport to Advanced Math	.51
Total	.71

SPSS used to find the relibility coeficient or Cronbach's alfa. Alpha of .71 was obtained for the total test items, included all of the new SAT skills. As noted by Arano-Ocuaman, a reliability coefficient of 0.70 or higher indicated an acceptable level of reliability in most educational research (Arano, 2010).

3.7 Procedures

Before starting the implementation of the study, the researcher received a local permission from the site administrators to conduct the study (see Appendix A). After receiving the permission from the site administrator, the procedure of the study was explained clearly to the participants in the study. In order to check the equivalency between the two groups, new SAT practice test was given to all students in both groups (experimental and control group).

The Study was implemented during the second term of the academic year 2015-2016 and was Six weeks in length. During this study, the control group received normal teaching instruction, while the experimental group received instruction using the flipped classroom teaching method. In the ordinary class setting, students were taught concepts during the allotted class time and homework was assigned accordingly. In the flipped classroom, students received instruction at home (via Khan Academy New SAT course , teacher made videos, Office mix, etc.) and completed homework in class. During class time students were able to discuss the assigned New SAT skill with their teacher and classmates. Before implementing the flipped classroom, the researcher ensured that each student participant had access to the New SAT materials through Khan Academy New SAT course or the teacher made videos, through Office mix. Every teaching week students in the experimental group received a new link to a new mix. The should watch it before the next lesson, containing a short quiz to check their understanding, even teacher was able to receive a report about the duration of time in seeing the readymade videos before the new class (see Appendix D).

The experimental group taught by flipped classroom instruction received the online videos links related to the three skills in New SAT test (Heart of algebra: https://www.khanacademy.org/test-prep/sat/sat-math-practice/new-sat-heart-of-algebra/, Problem Solving And Data Analysis: https://www.khanacademy.org/test-prep/sat/sat-math-practice/new-sat-problem-solving-data-analysis/, and Passport to Advanced Math: https://www.khanacademy.org/test-prep/sat/sat-math-practice/new-sat-problem-solving-data-analysis/v/sat-math-q1-easier), the online videos either from khan Academy (https://www.khanacademy.org/test-prep/sat) or created by the teacher to simplify some topics. All videos created using Office Mix software and published

to the office Mix site (https://mix.office.com/en-us/Home). Teacher was able to find a full report about student's views and the duration time of each video students spend it in learning at home. Teacher's videos were created using Camtasia Studio 7 software. Participants were able to see all of the New SAT videos by using their laptops, iPads, or their smart phones. The number of videos provided by khan academy and teacher made videos are distributed among the skills of the new SAT test and presented in table.

After ensured that Internet connection is available at student's home and they were able to access to the flipped classroom materials classroom (each student had Internet access at home and a device which allowed them to view the flipped classroom instruction (laptop or iPad). Researcher confirmed that students in the flipped classroom had access to the flipped material by engaging discussion amongst participating students and the flipped classroom teacher. All students were informed that the posttest would be after six weeks (at the end of term 2). The pre-and posttest done at the same time for both groups during the extra curricula activity period in two sessions (session 1: 25 minutes), and (session 2: 55 minutes).

3.8 Ethical Issues

For ethical considerations, the researcher got an approval for conducting the research from the school principle and student's parents. A descripted outline of the study, starting date, duration, participants, procedure, and the benefits of the study have been sent to the school administration, during the implementation period; the researcher updated the lead teacher with the student's participations and improvements. The participants in the study were equally treated with the greatest confidentially. At the same time, students received clear

information about the study. At the end of the study period, the result of the pre- and posttest distributed to the students with their marks and achievements.

3.9 Data Collection

Data like (the final score − score of Heart of algebra skill, score of Problem Solving and Data analysis skill, and score of Passport to advanced Math skill) for the pre-and posttest instruments mentioned before were entered and analyzed by using SPSS version 23 software.

The pretest data for student's academic achievement overall and in each part of the new SAT skills (Heart of Algebra, Problem Solving and Data Analysis, and Passport to Advanced Math) were examined for normality between the control and treatment groups. To check the homogeneity between the groups, an independent t-test was utilized, to determine if there was a difference in the pretest mean between the experimental and control groups using SPSS. The posttest data for student's academic achievement overall and in each part of the new SAT skills (Heart of Algebra, Problem Solving and Data Analysis, and Passport to Advanced Math) were examined for differences in the groups' mean between the experimental and control groups.

To determine if there was a statistically significant difference in the mean posttest scores between the experimental and control groups, four independent t- tests were used to analyze student data: the first independent t-test analyzed the academic achievement overall in both sections (section 1 and section 2) scores, the second independent t-test analyzed the achievement in the Heart of Algebra skills Score , the third independent t-test analyzed the achievement in the Problem Solving and Data Analysis skills Score, and the fourth independent t-test analyzed the achievement in

the Passport to Advanced Math skills Score. For this study, the researcher used $p < 0.05$ as the level of significance.

3.10 Summary

This chapter viewed the methodology of the study, which is a quantitative quasi-experimental design. At the beginning of the chapter, the specification of the participations was presented, including the academic cluster, their age, and nationality. The division of the two groups experimental and control group have been presented also. Then after the description of the study participants, the study instruments were explained in details, the pretest and posttest containing 58 new SAT skills questions, divided into two sections, one section without using calculator, and the other one students can use calculator. Both exams included questions related to the three main skills in the new SAT exam, Heart of Algebra, Problem Solving and Data Analysis, and Passport to Advanced Math. The pretest used to check the equivalency between the two groups before conducting the study. Validity and reliability of the test were tested, with a result of a valid and reliable test. The procedure of the study was described, starting from the pretest, followed by the intervention (applying the flipped classroom instruction with the experimental group), and the study ethical issues, and ended with the posttest and the result. SPSS version 23 has been used to analyze the result, using an independent sample t-test.

Chapter 4: Result

4.1 Chapter Overview

The main purpose of this study was to determine if there was a statistically significant difference in student academic achievement in the new SAT test score overall , and in each part of the new SAT skills (Heart of Algebra , Problem Solving and Data Analysis , and Passport to Advanced Math) between the eleventh grade students who received flipped classroom instruction and students who did not. This chapter presents the results for this study related to the research questions identified in Chapter one, and concludes with a brief summary of the results. For this quantitative quasi-experimental design study, IBM SPSS version 23 was used for statistical analysis.

4.2 Pretest

Before the implementation of the study, the researcher gave the participants in (the experimental and control groups) to check the equivalency between the two groups. There were a total of 58 academic achievement items on the pretest contain the new SAT test skills. Each item on the pretest was worth a single point. If the student responded correctly to a question, they received a point. Thus, the maximum number of points a student could receive on the academic achievement items for the pretest was 58. After the pretest was given to every student participant, the researcher graded each student's pretest, and entered the data into IBM's SPSS Statistics, Version 23. An independent t-test was analyzed on the control and experimental groups; and it was determined that the control group and experimental group were comparable in ability level. The mean for control group students ($M = 18.56$, $SD = 4.51$) was

comparable to the flipped students (*M* = 16.68, *SD* = 4.83). the result is shown in table 5.

Table 5: Descriptive Statistics of the Pretest Total Score

Pretest Total Score	Group	N	Mean	Std. Deviation
	Experimental	39	18.56	4.506
	Control	40	16.68	4.833

As seen in Table 6, There was homogeneity of variances for Pretest scores for experimental and control groups, as assessed by Levene's test for equality of variances (*p* = .472).

Table 6: Independent Sample t-test for Student Pretest

Pretest Total Score	Group	F	Sig.	t	df	Sig.(2-tailed)
	Equal variances assumed	.52	.47	1.8	77	.08
	Equal variances not assumed			1.8	76.85	.08

4.3 Descriptive Statistics for Posttest

To determine if there was a statistically significant difference in the mean posttest results in student academic achievement in the new SAT overall test, and in each part of the new SAT skills (Heart of Algebra, Problem Solving and Data Analysis, and Passport to Advanced Math) between the eleventh grade students who received flipped classroom instruction and students who did not, posttest data were compared. Table 7 includes the descriptive statistics of the posttest for the control and experimental groups. The descriptive statistics for the flipped classroom, instructional group 1, were as follows: A total of 39 student participants' posttest scores, which assessed all of the new SAT skills, included a Mean of 25.26 and a Standard Deviation

of 3.33; posttest scores which assessed Heart of Algebra skills included a Mean of 10.85 and a Standard Deviation of 2.33, posttest scores which assessed Problem Solving and Data Analysis skills included a Mean of 4.62 and a Standard Deviation of 1.248, posttest scores which assessed Passport to Advanced Math skills included a Mean of 9.97 and a Standard Deviation of 1.86.

The descriptive statistics for the control classroom, instructional group 2, were as follows: A total of 40 student participants' posttest scores, which assessed all of the new SAT skills, included a Mean of 20.78 and a Standard Deviation of 5.47; posttest scores which assessed Heart of Algebra skills included a Mean of 8.60 and a Standard Deviation of 2.26, posttest scores which assessed Problem Solving and Data Analysis skills included a Mean of 4.33 and a Standard Deviation of 1.7, posttest scores which assessed Passport to Advanced Math skills included a Mean of 7.85 and a Standard Deviation of 2.33.

Table 7: Descriptive Statistics of the Posttest Score

	Group	N	Mean	Std. Deviation
Total Score of Posttest	Experimental	39	25.26	3.330
	Control	40	20.78	5.47
Total Score of Heart of Algebra	Experimental	39	10.85	2.33
	Control	40	8.60	2.26
Total Score of Passport to Advanced Math	Experimental	39	9.79	1.87
	Control	40	7.85	2.33
Total Score of Problem Solving and Data analysis	Experimental	39	4.62	1.25
	Control			1.70
		40	4.33	

4.4 Research Question 1

Is there any significant difference in the New SAT achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

Table 8: Independent Samples t-test for Student Posttest

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Total Score of Post test	Equal variances assumed	5.03	.028	4.39	77	.000
	Equal variances not assumed			4.41	64.73	.000

Table 8 shows that there exists a difference in the mean between the experimental (*Mean* =25.26, *N*=39, *SD* 3.33) and the controlled group (*Mean*=20.78, *N*=40, *SD* 5.47) in the Posttest overall score. There was a statistically significant difference in mean Posttest score between experimental and control, $t(79) = 4.39$, $p = .00$. There was a statistically significant difference between means ($p < .05$).

Size effect was calculated using Cohen's Alfa, $d = 0.98$, this value represented a large effect size. Using Cohen's *d* criteria (Cohen, 1988). As such, a *d* of 0.80 or higher constituted a large effect size; an effect size of 0.50 to 0.79 constituted a moderate effect size; an effect size of 0.20 to 0.49 was regarded as a small effect size; and a *d* below 0.20 was regarded as being trivial in nature.

4.5 Research Question 2

Is there any significant difference in the New SAT- HEART OF ALGEBRA skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

Table 9: Independent Samples t-test for Student Posttest in Heart of Algebra skills

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Total Score of Post test	Equal variances assumed	.502	.48	4.34	77	.00
	Equal variances not assumed			4.34	76.75	.00

Table 9 shows that there exists a difference in the mean between the experimental (*Mean* =10.85, *N*=39, *SD* 2.33) and the controlled group (*Mean*=8.60, *N*=40, *SD* 2.26) in the Posttest Heart of algebra skills score. There was a statistically significant difference in mean Posttest hear of algebra skills score between experimental and control, $t(79) = 4.34$, $p = .00$. There was a statistically significant difference between means ($p < .05$).

4.6 Research Question 3

Is there any significant difference in the New SAT- PROBLEM-SOLVING AND DATA ANALYSIS skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

Table 10: Independent Samples t-test for Student Posttest in Problem Solving skills

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Total Score of Post test	Equal variances assumed	3.113	.082	.863	77	.39
	Equal variances not assumed			.867	71.59	.39

The results from the independent t-test assuming equal variances were as follows: $t(79) = 0.86$. The two groups did not differ statistically with significance of $p = .39$. The mean of the scores from the flipped classroom student academic achievement posttest in problem solving skills items was not significantly different from the mean of the scores from the ordinary classroom students' academic achievement posttest items as noted in Table 10.

4.7 Research Question 4

Is there any significant difference in the New SAT- PASSPORT TO ADVANCED MATH skills achievement between students who studied in the flipped classroom strategy compare to the ordinary way of teaching math?

Table 11: Independent Samples t-test for Student Posttest in Passport to Advanced Math skills

| | | Levene's Test for Equality of Variances | | | | |
		F	Sig.	t	df	Sig. (2-tailed)
Total Score of Post test	Equal variances assumed	2.840	.096	4.092	77	.00
	Equal variances not assumed			4.104	74.266	.00

Table 11 shows that there exists a difference in the mean between the experimental (*Mean* =9.97, *N*=39, *SD* 1.87) and the controlled group (*Mean*=7.85, *N*=40, *SD* 2.33) in the Posttest Passport to Advanced Math skills score. There was a statistically significant difference in mean Posttest hear of algebra skills score between experimental and control, $t(79) = 4.104$, $p = .00$. There was a statistically significant difference between means ($p < .05$).

4.8 Summary of Result

The chapter reported five main results, first, the results of the pretest showed that the mean of the group taught in the ordinary method group scores were slightly higher than the mean of the sections taught using flipped methods. for control group students ($M = 18.56$, $SD = 4.51$) was comparable to the flipped students ($M = 16.68$, $SD = 4.83$). The t-test analysis of the pretest overall score ($p = .47$) showed that the two groups of the study (experimental group and control group) were equivalence in term of background in the new SAT Test and its skills. second results focused on the students' achievements in the posttest, when flipped classroom instruction has been implemented. The posttest result showed that the experimental group achieved a

higher mean score than the control group on the overall score, even the result of posttest in Heart of Algebra, and Passport to Advanced Math, showed that the significant between the two group. But the result in the posttest Problem solving and Data analysis skills, didn't show any significant between the two groups, which will be discuss in details in the coming chapter.

Chapter 5: Discussion

5.1 Chapter Overview

The main purpose of this study was to determine if there was a statistically significant difference in student academic achievement in the new SAT test score overall , and in each part of the new SAT skills (Heart of Algebra , Problem Solving and Data Analysis , and Passport to Advanced Math) between the eleventh grade students who received flipped classroom instruction and students who did not. This chapter discuss the results of the data presented in chapter 4. It also discusses the results in relation to the literature review (the previous research studies results presented in chapter 2). The chapter will discuss also limitations of the study. In addition to that the chapter will discuss the implication of the result for practice, followed by recommendations for further research.

5.2 Discussion of The Result

5.2.1 Student's Overall Score in the Pre- and Posttest

Data related to the post-test, which took place after implementation of the intervention with the experimental group was presented in chapter 4. The comparison between the experimental and the control groups' performances on the post-test showed that the experimental group achieved a higher mean score than the control group on the overall score. An independent t-test analysis was found to be statistically significant $t(79) = 4.387$, $p = .000$.This result presented the effectiveness of the flipped classroom instruction in teaching new SAT skills overall, this significant differences between the two groups may be because the experimental group had the chance to practice more and they had the chance to interact more with their teachers and their friends , they shared their experience in each SAT questions during the face to face

class time.at the same time the control group received the same practice materials like (new SAT 2016 Practice book and 2 practice tests with answer key) , but they couldn't be able to cover more questions at home, they already had another homework related to the algebra 2 curriculum , and they have different tasks for other subjects , when the teacher gave them some questions as a homework , the majority of the students left it back to the teacher for explanation , they needs to interact with teacher to simplify the questions. Also the variety of the online videos (khan academy readymade videos or teacher made videos) helped students to understand more and practice more inside the class.

5.2.2 Student's Score in the Posttest –Heart of Algebra Skills

Result related to the Heart of Algebra skills in the posttest showed that the mean of the experimental group taught in the flipped classroom instruction scores were significant compare to the mean of the control group taught using ordinary methods. An independent t-test indicates that the difference is statistically significant in the Heat of Algebra skills score, $t(79) = 4.343$, $p = .000$. This result can be explained as the student's background in the Heart of Algebra skills was good, students used the videos to refresh their minds with the previous algebra 1 concepts like (solving, interpreting, graphing linear of equations and inequalities – system of linear equations and inequalities) , which teaching those concepts talk place in grade 7 to 9, in other word Heart of Algebra skills were the basics, and students used to use the basics in every math lessons. Flipped classroom had a positive impact in teaching Heart of Algebra skills. For example, solving linear equation or inequality level, is not like dealing with problem solving questions, which needs a multi steps procedure. Another reason, it could be the level of the questions presented through the video were easy to

understand, like https://www.khanacademy.org/test-prep/sat/sat-math-practice/new-sat-heart-of-algebra/.

5.2.3 Student's Score in the Posttest –Problem Solving and Data Analysis

Result related to the Problem Solving and Data Analysis skills in the posttest showed that there was no significant difference between the two groups (experimental group and control group mean score in the Problem Solving and Data Analysis, The results from the independent t-test assuming equal variances were as follows: $t(79) =$ 0.863. The two groups did not differ statistically with significance of $p = .391$. This result can be explained as the Problem Solving skills need more practices, not only in solving the questions, teacher should teach students how to deal with a problem solving questions, students should learn a variety of techniques in solving a problem solving questions, this will not happen through the posted video in the flipped classroom instruction, students found the posted videos not useful at all as a preparation for the next class, because each question in problem solving skills had an idea, which means the videos trained students in specific type of questions not in how to deal with problem solving skills questions.

However, these finding was confirmed by Results of Program for International Students Assessment (PISA2012), which showed that students' scores in Problem Solving in Singapore, Korea, and Japan are higher than students in all other participating countries. The UAE ranked in problem Solving was 40 among the 44 participants with a score of 411. Female result was better than male results in all domains, but there were no significant differences between males and females result in math, and the lowest score for both of males and females was in problem solving. (OECD, 2014). So there was a wide difference between the student's abilities in

solving problem solving skills among the countries, this differences may be because of the curriculum assigned for the students is not enforcing the problem solving skills and real life situation.it should cover a non-routine problem in real life context. Comparing the problem solving skills in the new SAT with the classroom applications, teachers should prepare students to be a problem solver, and critical thinker not only understanding the basics. Including the research site, many students were performing very well in the school based quizzes, but they didn't perform the same in the international exams, which contain a verity skill, for this reason teachers should have focused more in problem solving, and it's not only in teaching, it should be also in student's assessment.

5.2.4 Student's Score in the Posttest –Passport to Advanced Math Skills

Result related to the Passport to Advanced Math skills in the posttest showed that the mean of the experimental group taught in the flipped classroom instruction scores were significant than the mean of the control group taught using ordinary methods., $t(79) = 4.092$, $p = .000$. This significant differences happened in Passport to Advanced math and not happened in problem solving skills because, Passport to Advanced Math covering mostly the algebra 2 concepts like (solving, and interpreting quadratic equations, operations with polynomial and rational functions, exponential functions, ...)

Those algebra 2 concepts were taught to the students recently in grade 11, and they had a chance to practice more before the implementation of the study. For example, the Passport to Advanced Math skills, included the quadratic functions, exponential functions, logarithmic functions, and the many other skills as mentioned in chapter 3, which is aligned with the common core standards of algebra 2.

5.3 Discussion of The Result in Relation to the Literature Review

Related to the literature review in chapter 2, many studies presented a positive impact in student's achievements when the studied by flipped classroom such as Love et all, 2013. This study found that the average change in score for the students in the flipped section was significantly greater than for those in the ordinary section ($p <$ 0.034). When comparing the third exam to the first exam, the average change in score for those in the flipped classroom section was again significantly greater than for those in the ordinary section ($p <$ 0.012).

Studies like conducted in the effect of using flipped classroom in teaching mathematics, like Quint, 2015, and Martin, 2015, were conducted in college of algebra and Calculus. The result showed a positive impact of the flipped classroom, which will explain why there were a significant in Heart of Algebra skills, and passport to Advanced Math between the two groups, and no significant in problem solving skills.

Another study showed a significant difference, study conducted by Mireille Farah (2014) in the Applied Technology High School (ATHS) in United Arab Emirates, she found that there was a statistically significant differences between the mean scores in favor of the students in the experimental group. Furthermore, the results showed that this improvement in the writing performance is largely attributable to the Flipped Instruction method of teaching. Students' attitudes towards the Flipped Instruction proved to be equally favorable.

Those studies were matching with the research study result in all of the study questions except the problem solving skills part, the research study showed there was no significant difference between the experimental group and control group like the study of Johnson and Renner (2012), this study found that there was no significant

difference between the two groups of the secondary computer applications course among six weeks. The similarity between this research and the research study is the duration of the flipped classroom instruction course, which is six weeks only. Which not enough to train students through flipped classroom instruction in computer applications like a problem solving skills in the research study. Finally, the result of this study showed that using online videos in a flipped classroom, may not help the students to understand the hard concepts at home, which need an instructor-modeled problem on the board, seeing math videos online at home will create a lack of face-to face interaction, which will affect the students' understanding (Mazza , 2015).

5.4 Recommendations and Suggestions for Further Research

As mentioned before, some studies showed that flipped classroom instruction could improve students' achievements compared with the ordinary classroom instruction, on the other hand some studies showed that, the flipped classroom couldn't. As a conclusion from the research study and the literature review of flipped classroom studies, there are many factors could affect the result of applying flipped classroom instruction, like the teacher's readiness and teacher's qualifications, the content, the quality of the videos, the in-class activities, and the student's commitment of seeing the videos before the lesson. This study may help teachers in the research site for planning and flipping some of their lesson to catch up with curriculum pacing, it may help also in the intervention plans of the weak students, teachers can use flipped classroom to improve the level of students, at the same time teachers teaching international exam concepts like SAT, AP calculus can use flipped classroom instruction to increase the amount of practice questions.

I recommend to any educator who is going to implement a flipped classroom the following suggestions.

- **Teacher may use flipped classroom instruction as a part of intervention plans:** In many educational field, including the research site, teachers looking for the best practice to improve the level of the weak students, or student who are failed in any, exam, or students who need an extra support. Teachers can use a flipped classroom instruction or in-class flipped classroom instruction to help students understand the concepts and also to review the lessons before their exams.

- **Schools can create an international exam committee, to prepare students for any international exam using flipped classroom instruction:** This committee will consist members who are teaching international exams practices like SAT, AP, …, and encourage them to prepare their videos and put it in a video bank, for example SAT practice video bank, will contain different ideas, and different skills, which will allow any teacher to use it in flipped classroom instructions.

- **Provide a professional development course for the teachers and students before applying the flipped classroom instruction**: One of the very important part in flipping the classroom is teachers and students should be ready, teachers should be ready for creating videos and activities, students should have trained how to see the video. And how to use the content delivered by the video in understanding the main concepts.

- Increase the communication between the administrators, teachers, students, and parents: Before the implementation of any flipped classroom instruction

teachers should explain to the administrators, parents, and students the purpose of using flipped classroom instruction in teaching.

- **Increase the duration of the study**: as a suggestion for any further research implementation flipped classroom periods should be increased, students will be familiar with flipped classroom and even the result will be more reliable.

- **Use flipped classroom in teaching the basics**: as a suggestion for the curriculum developers, when they are creating the curriculum documents, which include the unit plan and activates (curriculum mapping), they can assign the flipped classroom instructions as a choice of teaching the basics in each unit, or during the review lesson, in order to save more time for teaching the higher order thinking skills in mathematics.

Bibliography

Abbott, L. (2007). *Social learning theory*. Retrieved from

    http://teachnet.edb.utexas.edu/~lynda_abbott/Social.html

Alvarez, B. (2012). FLIPPING THE CLASSROOM: Homework in class, lessons at

    home. *The Education Digest, 77*(8), 18-21. Retrieved from

    http://search.proquest.com/docview/1008666019?accountid=62373

Al-Zahrani, A. M. (2015). From passive to active: The impact of the flipped

    through social learning platforms on higher education students' creative

    thinking. *Br J Educ Technol British Journal of Educational Technology,*

    46(6), 1133-1148. doi:10.1111/bjet.12353.

Anderson, L., Krathwohl, R., Airasian, P., Cruikshank, K., Mayer, R., Pintrich, P.,

    Raths, J., & Wittrock, M. (Eds.). (2001). *Taxonomy for learning, teaching,*

    and assessing: A revision of Bloom's taxonomy. New York, NY: Longman.

Arano-Ocuaman, J. (2010). *Differences in student knowledge and perception of*

    learning experiences among non-traditional students in blended and face-to-

    face classroom delivery (Order No. 3432383). Available from ProQuest

    Dissertations & Theses Global. (821438553). Retrieved from

    http://search.proquest.com/docview/821438553?accountid=62373.

A taxonomy for learning, teaching, and assessing; a revision of bloom's taxonomy of

    educational objectives, complete edition. (2001). *Reference and Research*

    Book News, 16(3) Retrieved from

    http://search.proquest.com/docview/199579418?accountid=62373.

Baker, J. W. (2000). *The "Classroom Flip": Using web course management tools to become the guide by the side.* In J.A. Chambers (Eds.) *Selected papers from the 11th International Conference on College Teaching and Learning* (pp. 9-17).

Bandura, A. (1977). *Social learning theory.* New Jersey: Prentice-Hall. http://garfield.library.upenn.edu/classics1991/A1991GD62000001.pdf

Bergmann, J.,& Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International Society for Technology in Education. Washington, D.C.

Bergmann, J., & Sams, A. (2012b). How the flipped classroom is radically transforming learning. *The Daily Riff*. Retrieved March 13, 2015, from http://www.thedailyriff.com/articles/how-the-flipped-classroom-is-radically-transforming-learning-536.php

Berrett, D. (2012). How 'flipping' the classroom can improve the traditional lecture. *The Education Digest, 78*(1), 36-41. Retrieved from http://search.proquest.com/docview/1039300597?accountid=62373

Bissell, A. N. & Lemons, P. P. (2006). A new method for assessing critical thinking in the classroom. *BioScience*, *56*(1), 66-72.

Brunsell, E., & Horejsi, M. (2011). "Flipping" your classroom. *Science Teacher*, *78*(2), 10. Bull, G., & Kjell, W. (2013).

Byrne, T. (1989). *The Evolution of Distance Education*. Calgary, Alberta: University of Calgary Press.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.).Hillsdale, NJ: Lawrence Erlbaum.

College Board (2006b). *The SAT program handbook: A comprehensive guide to the SAT program for school counselors and admission officers*. Princeton, NJ:Author.

College Board (2006d). *Test characteristics of the SAT Reasoning Test: Reliability, difficultly levels, completion rates.* Retrieved on May 13, 2015, from http://www.collegeboard.com/prod_downloads/highered/ra/sat/sat-test-characteristics.pdf.

College Board (2015). *Focus on Math that Matters Most.* Retrieved April 15, 2015, From https://www.collegeboard.org/pdf/focus_on_math_that_matters_most.pdf.

Gultekin, H. (2006). *Vygotsky's approach to cognitive development* (Order No. 1438830). Available from ProQuest Dissertations & Theses Global. (305293951). Retrieved from http://search.proquest.com/docview/305293951?accountid=623733 .

Fallows, N. (2013). A Flipped Approach to Vocabulary Teaching in HCT Dubai Colleges Foundations Level 03: Utilising Spaced Repetition for Consolidation. *Ejournal,* (December 2013), 1-5. Retrieved May 11, 2016, from http://ejournal.hct.ac.ae/wp-content/uploads/2013_Article05.pdf

Farah, M. (2014). *The Impact of Using Flipped Classroom Instruction on the Writing Performance of Twelfth Grade Female Emirati Students in the Applied Technology High School (ATHS).* (Unpublished master's thesis). The British University in Dubai.

Fink, Z. (2011, September 30). Big thinkers: Salman Khan on liberating the classroom for creativity. *Edutopia*: *K-12 Education & Learning Innovations with Proven Strategies that Work.* Retrieved March 12, 2016, from http://www.edutopia.org/salman-khan-academy- flipped-classroom-video

Fulton, K. P. (2012a). 10 reasons to flip. *Phi Delta Kappan*, *94*(2), 20.

Gojak, L. (2012). To flip or not to flip: That is not the question! *National Council of Teachers of Mathematics.* Retrieved from http://nctm.org/about/content.aspx?id=34585.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). *A review of flipped learning*. Retrieved from http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/4 1/LitReview_FlippedLearning.pdf

HCT. (2015, April 7). *HCT Reinforce UAE's Smart Technology Initiatives at 3rd Annual Mobile Learning Conference.* Retrieved May 4, 2015, from HCT website: http://news.hct.ac.ae/en/2015/04/hct-reinforces-uaes-smart-technology-initiatives-at-3rd-annual-mobile-learning-conference.

Heilesen, S.B. (2010). What is the academic efficacy of podcasting? *Computers & Education*, doi:10.1016/j.compedu.

Islas, A. L. Bradbury, E. E. (2011). Improving student learning in calculus through applications. *International Journal of Mathematical Education in Science and Technology*, 42(5), 591- 604.

Johnson, L. & Renner, J. (2012). Effect of the flipped classroom model on a

    secondary computer applications course: student and teacher perceptions,

    questions and student achievement (Doctoral Dissertation). University of

    Louisville.

Jones, K., Jones, J., & Vermette, P. J. (2010). The constructivist mathematics

    classroom. *Mathematics Teaching,* (219), 33-35.

KahnAcademy.org. Retrieved from https://www.khanacademy.org .

Khan, S. (2011). About Khan Academy. *Khan Academy*. Retrieved April

    11, 2016, from http://www.khaacademy.org/abou

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday*

    life.Massachusetts: Cambridge University Press.

Love, B., Hodge, A., Grandgenett, N., & Swift, A. W. (2014). Student learning and

    perceptions in a flipped linear algebra course. *International Journal of*

    Mathematical Education in Science and Technology, 45(3), 317-324. doi:

    http://dx.doi.org/10.1080/0020739X.2013.822582

Martin, A. G. (2015). *The impact of flipped instruction on middle school*

    mathematics achievement (Order No. 3724702). Available from ProQuest

    Dissertations & Theses Global. (1727612899). Retrieved from

    http://search.proquest.com/docview/1727612899?accountid=623733

Mazza, J. T. (2015). *The relationship between video-based instruction and student achievement in an online math course* (Order No. 3718009). Available from ProQuest Dissertations & Theses Global. (1711754296). Retrieved from http://search.proquest.com/docview/1711754296?accountid=62373

McGarr, O. (2009). A review of podcasting in higher education: its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3), 309–321.

Miller, P. (2011). *Theories of developmental psychology* (5th ed.). New York: Worth.

Ministry of Education. (2010, February 24). *The Ministry of Education Strategy 2010 – 2020.*Retrieved May 9, 2016, from https://www.moe.gov.ae/Arabic/Docs/MOE%20_Strategy.pdf

Mohammed Bin Rashid Smart Learning Program. (2012, April). *History & Accomplishments.* Retrieved May 10, 2016, from http://smartlearning.gov.ae/get-us-know-us/

OECD. (2013). *PISA 2012 Results in Focus-What 15-year-olds know and what they can do with what they know*. Retrieved April 28, 2016, from https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf.

Open University. (2014). Teaching & learning. Royal Charter (RC 000391). Financial Conduct Authority. Retrieved May 25, 2015 from http://www.open.ac.uk/about/mail/strategy/teacing-learning-ou

Papadapoulos, C. & Roman, A.S. (2010). Implementing an inverted classroom model in engineering statistics: Initial results. *American Society for Engineering*

Statistics. Proceedings of the 40th ASEE/IEEE Frontiers in Education
Conference, Washington, DC, October 2010.

Perry, S. A. (2012). *A descriptive case study of 21st century skills in schools:
Exploring the challenges and opportunities of adaptive change and
innovation for educational leaders and the schools they lead* (Order No.
3504374). Available from ProQuest Dissertations & Theses Global: Social
Sciences. (1011479720). Retrieved from
http://search.proquest.com/docview/1011479720?accountid=62373

Pierce, R., & Fox, J. (2012). Vodcasts and active-learning exercises in a "flipped
classroom" model of a renal pharmacotherapy module. *American Journal of
Pharmaceutical Education*, *76*(10), article 196.

Pink, D. (2010). Think tank: Flip-thinking - the new buzz word sweeping the US.
The Telegraph. Retrieved April 11, 2016 from
http://www.telegraph.co.uk/finance/businessclub/7996379/Daniel-Pinks
Think-Tank-Flip-thinking-the-new buzz-word- sweeping-the-US.html

Popham, W. J. (2014). *Classroom assessment: What teachers need to know* (Seventh
edition ed.). New Jersey: Pearson Education.

Quint, C. L. (2015). *A study of the efficacy of the flipped classroom model in a
university mathematics class* (Order No. 3707108). Available from ProQuest
Dissertations & Theses Global. (1695832181). Retrieved from
http://search.proquest.com/docview/1695832181?accountid=62373

Ruddick, K. W. (2012). *Improving chemical education from high school to college*

using a more hands-on approach (Order No. 3529991). Available from

ProQuest Dissertations & Theses Global. (1082023572). Retrieved from

http://search.proquest.com/docview/1082023572?accountid=62373

Saunders, J. M. (2014). *The flipped classroom: Its effect on student academic

achievement and critical thinking skills in high school mathematics* (Order

No. 3645482). Available from ProQuest Dissertations & Theses Global.

(1639087375). Retrieved from

http://search.proquest.com/docview/1639087375?accountid=62373

Stallworth-Stevens, H. (1995). *Varying high school mathematics students' verbal

interactions to test vygotsky's theory of concept formation* (Order No.

9623458). Available from ProQuest Dissertations & Theses Global.

(304296721). Retrieved from

http://search.proquest.com/docview/304296721?accountid=623733

Strayer, J (2007). *The effects of the classroom flip on the learning environment: A

comparison of learning activity in a traditional classroom and a flip

classroom that used an intelligent tutoring system.* (Doctoral dissertation).

Retrieved from Proquest UMI.

Syam, M. (2014, September 10). *Possibility Of Applying Flipping Classroom

Method In Mathematics Classes In Foundation Program At Qatar University*.

Retrieved May 3, 2016, from

http://www.ocerint.org/Socioint14_ebook/papers/68.pdf

Tucker, B. (2012). The flipped classroom. *Education Next, 12(1), 82-83*. Retrieved

from http://educationnext.org/the-flipped-classroom

Williams, Beth (2013). *How I flipped my classroom*. NNNC Conference, Norfolk, NE.

Young, C. Y., Georgiopoulos, M., Hagen, S. C., Geiger, C. L., Dagley-Falls, M.

Zappe, S. Leicht, R., Messner, J., Litzinger, T. & Lee, H. (2009). "Flipping" the classroom to explore active learning in a large undergraduate course. *American Society for Engineering Education.*

Appendix A – New SAT Test Specifications

SAT MATH TEST CONTENT SPECIFICATIONS		
Time Allotted	80 minutes	
Calculator Portion	55 minutes	
No-Calculator Portion	25 minutes	
	Number	**Percentage of test**
Total Items	58 questions	100%
Multiple Choice (MC, 4 options)	45 questions	78%
Student-Produced Response (SPR—grid-in)	13 questions	22%
Contribution of Items to Subscores		
Heart of Algebra	19 questions	33%
Analyzing and fluently solving linear equations and systems of linear equations		
Creating linear equations and inequalities to represent relationships between quantities and to solve problems		
Understanding and using the relationship between linear equations and inequalities and their graphs to solve problems		
Problem Solving and Data Analysis	17 questions	29%
Creating and analyzing relationships using ratios, proportional relationships, percentages, and units		
Representing and analyzing quantitative data		
Finding and applying probabilities in context		
Passport to Advanced Math	16 questions	28%
Identifying and creating equivalent algebraic expressions		
Creating, analyzing, and fluently solving quadratic and other nonlinear equations		
Creating, using, and graphing exponential, quadratic, and other nonlinear functions		
Additional Topics in Math*	6 questions	10%
Solving problems related to area and volume calculations in context		
Applying definitions and theorems related to lines, angles, triangles, and circles		
Working with right triangles, the unit circle, and trigonometric functions		

Appendix B – Online Video Report

SLIDE PROGRESS		QUIZZES AND POLLS NO.	CORRECT	APPS NO.	TIME SPENT OVERALL	
	100% Completed	0	0%	0		3 m 28 s
	100% Completed	0	0%	0		3 m 28 s
	100% Completed	0	0%	0		3 m 28 s
	100% Completed	0	0%	0		3 m 28 s
	100% Completed	0	0%	0		3 m 28 s
	100% Completed	0	0%	0		3 m 27 s
	100% Completed	0	0%	0		4 m 29 s
	100% Completed	0	0%	0		4 m 11 s

Appendix C – Pretest

Math Test – No Calculator
25 MINUTES, 20 QUESTIONS

DIRECTIONS

For questions 1-15, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 16-20,** solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 16 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

NOTES

1. The use of a calculator **is not permitted.**

2. All variables and expressions used represent real numbers unless otherwise indicated.

3. Figures provided in this test are drawn to scale unless otherwise indicated.

4. All figures lie in a plane unless otherwise indicated.

5. Unless otherwise indicated, the domain of a given function f is the set of all real numbers x for which $f(x)$ is a real number.

REFERENCE

$A = \pi r^2$ $A = \ell w$ $A = \dfrac{1}{2} bh$ $c^2 = a^2 + b^2$ Special Right Triangles
$C = 2\pi r$

$V = \ell wh$ $V = \pi r^2 h$ $V = \dfrac{4}{3} \pi r^3$ $V = \dfrac{1}{3} \pi r^2 h$ $V = \dfrac{1}{3} \ell wh$

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

1

If $5x + 6 = 10$, what is the value of $10x + 3$?

A) 4

B) 9

C) 11

D) 20

2

$$x + y = 0$$
$$3x - 2y = 10$$

Which of the following ordered pairs (x, y) satisfies the system of equations above?

A) $(3, -2)$

B) $(2, -2)$

C) $(-2, 2)$

D) $(-2, -2)$

3

A landscaping company estimates the price of a job, in dollars, using the expression $60 + 12nh$, where n is the number of landscapers who will be working and h is the total number of hours the job will take using n landscapers. Which of the following is the best interpretation of the number 12 in the expression?

A) The company charges $12 per hour for each landscaper.

B) A minimum of 12 landscapers will work on each job.

C) The price of every job increases by $12 every hour.

D) Each landscaper works 12 hours a day.

4

$$9a^4 + 12a^2b^2 + 4b^4$$

Which of the following is equivalent to the expression shown above?

A) $(3a^2 + 2b^2)^2$

B) $(3a + 2b)^4$

C) $(9a^2 + 4b^2)^2$

D) $(9a + 4b)^4$

3 ⊠ **3**

5

$$\sqrt{2k^2 + 17} - x = 0$$

If $k > 0$ and $x = 7$ in the equation above, what is the value of k ?

A) 2
B) 3
C) 4
D) 5

6
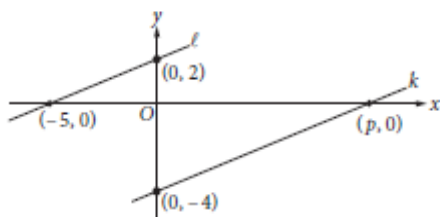
In the xy-plane above, line ℓ is parallel to line k. What is the value of p ?

A) 4
B) 5
C) 8
D) 10

7

If $\dfrac{x^{a^2}}{x^{b^2}} = x^{16}$, $x > 1$, and $a + b = 2$, what is the value

of $a - b$?

A) 8
B) 14
C) 16
D) 18

8

$$nA = 360$$

The measure A, in degrees, of an exterior angle of a regular polygon is related to the number of sides, n, of the polygon by the formula above. If the measure of an exterior angle of a regular polygon is greater than $50°$, what is the greatest number of sides it can have?

A) 5
B) 6
C) 7
D) 8

3 ❎ **3**

9

The graph of a line in the xy-plane has slope 2 and contains the point $(1, 8)$. The graph of a second line passes through the points $(1, 2)$ and $(2, 1)$. If the two lines intersect at the point (a, b), what is the value of $a + b$?

A) 4

B) 3

C) −1

D) −4

10

Which of the following equations has a graph in the xy-plane for which y is always greater than or equal to −1 ?

A) $y = |x| - 2$

B) $y = x^2 - 2$

C) $y = (x - 2)^2$

D) $y = x^3 - 2$

11

Which of the following complex numbers is equivalent to $\dfrac{3 - 5i}{8 + 2i}$? (Note: $i = \sqrt{-1}$)

A) $\dfrac{3}{8} - \dfrac{5i}{2}$

B) $\dfrac{3}{8} + \dfrac{5i}{2}$

C) $\dfrac{7}{34} - \dfrac{23i}{34}$

D) $\dfrac{7}{34} + \dfrac{23i}{34}$

12

$$R = \frac{F}{N + F}$$

A website uses the formula above to calculate a seller's rating, R, based on the number of favorable reviews, F, and unfavorable reviews, N. Which of the following expresses the number of favorable reviews in terms of the other variables?

A) $F = \dfrac{RN}{R - 1}$

B) $F = \dfrac{RN}{1 - R}$

C) $F = \dfrac{N}{1 - R}$

D) $F = \dfrac{N}{R - 1}$

13

What is the sum of all values of m that satisfy
$2m^2 - 16m + 8 = 0$?

A) -8

B) $-4\sqrt{3}$

C) $4\sqrt{3}$

D) 8

14

A radioactive substance decays at an annual rate of 13 percent. If the initial amount of the substance is 325 grams, which of the following functions f models the remaining amount of the substance, in grams, t years later?

A) $f(t) = 325(0.87)^t$

B) $f(t) = 325(0.13)^t$

C) $f(t) = 0.87(325)^t$

D) $f(t) = 0.13(325)^t$

15

The expression $\dfrac{5x - 2}{x + 3}$ is equivalent to which of the following?

A) $\dfrac{5 - 2}{3}$

B) $5 - \dfrac{2}{3}$

C) $5 - \dfrac{2}{x + 3}$

D) $5 - \dfrac{17}{x + 3}$

16

The sales manager of a company awarded a total of $3000 in bonuses to the most productive salespeople. The bonuses were awarded in amounts of $250 or $750. If at least one $250 bonus and at least one $750 bonus were awarded, what is one possible number of $250 bonuses awarded?

17

$$2x(3x + 5) + 3(3x + 5) = ax^2 + bx + c$$

In the equation above, a, b, and c are constants. If the equation is true for all values of x, what is the value of b ?

18
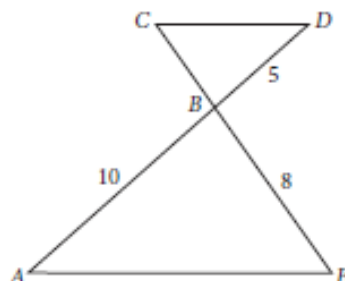
In the figure above, $\overline{AE} \parallel \overline{CD}$ and segment AD intersects segment CE at B. What is the length of segment CE ?

19
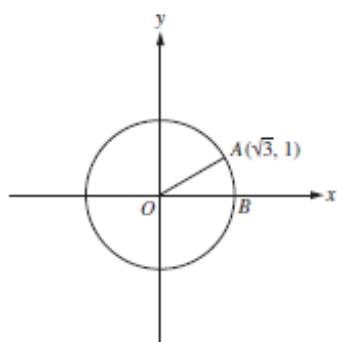
In the xy-plane above, O is the center of the circle, and the measure of $\angle AOB$ is $\dfrac{\pi}{a}$ radians. What is the value of a ?

20

$$ax + by = 12$$
$$2x + 8y = 60$$

In the system of equations above, a and b are constants. If the system has infinitely many solutions, what is the value of $\dfrac{a}{b}$?

4 🖩 4

Math Test – Calculator

55 MINUTES, 38 QUESTIONS

Turn to Section 4 of your answer sheet to answer the questions in this section.

DIRECTIONS

For questions 1-30, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 31-38**, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 31 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

NOTES

1. The use of a calculator **is permitted**.

2. All variables and expressions used represent real numbers unless otherwise indicated.

3. Figures provided in this test are drawn to scale unless otherwise indicated.

4. All figures lie in a plane unless otherwise indicated.

5. Unless otherwise indicated, the domain of a given function f is the set of all real numbers x for which $f(x)$ is a real number.

REFERENCE

REFERENCE

$A = \pi r^2$
$C = 2\pi r$
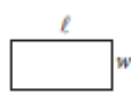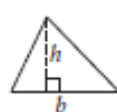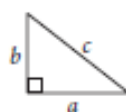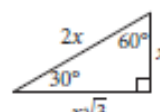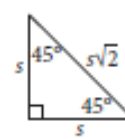
$A = \ell w$

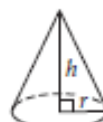$A = \frac{1}{2}bh$

$c^2 = a^2 + b^2$

Special Right Triangles

$V = \ell wh$

$V = \pi r^2 h$

$V = \frac{4}{3}\pi r^3$

$V = \frac{1}{3}\pi r^2 h$

$V = \frac{1}{3}\ell wh$

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

4 🖩 **4**

1

A musician has a new song available for downloading or streaming. The musician earns $0.09 each time the song is downloaded and $0.002 each time the song is streamed. Which of the following expressions represents the amount, in dollars, that the musician earns if the song is downloaded d times and streamed s times?

A) $0.002d + 0.09s$

B) $0.002d - 0.09s$

C) $0.09d + 0.002s$

D) $0.09d - 0.002s$

2

A quality control manager at a factory selects 7 lightbulbs at random for inspection out of every 400 lightbulbs produced. At this rate, how many lightbulbs will be inspected if the factory produces 20,000 lightbulbs?

A) 300

B) 350

C) 400

D) 450

3

$$\ell = 24 + 3.5m$$

One end of a spring is attached to a ceiling. When an object of mass m kilograms is attached to the other end of the spring, the spring stretches to a length of ℓ centimeters as shown in the equation above. What is m when ℓ is 73 ?

A) 14

B) 27.7

C) 73

D) 279.5

4 🖩 **4**

Questions 4 and 5 refer to the following information.

The amount of money a performer earns is directly proportional to the number of people attending the performance. The performer earns $120 at a performance where 8 people attend.

4

How much money will the performer earn when 20 people attend a performance?

A) $960

B) $480

C) $300

D) $240

5

The performer uses 43% of the money earned to pay the costs involved in putting on each performance. The rest of the money earned is the performer's profit. What is the profit the performer makes at a performance where 8 people attend?

A) $51.60

B) $57.00

C) $68.40

D) $77.00

6

When 4 times the number x is added to 12, the result is 8. What number results when 2 times x is added to 7 ?

A) -1

B) 5

C) 8

D) 9

7

$$y = x^2 - 6x + 8$$

The equation above represents a parabola in the xy-plane. Which of the following equivalent forms of the equation displays the x-intercepts of the parabola as constants or coefficients?

A) $y - 8 = x^2 - 6x$

B) $y + 1 = (x - 3)^2$

C) $y = x(x - 6) + 8$

D) $y = (x - 2)(x - 4)$

8

In a video game, each player starts the game with k points and loses 2 points each time a task is not completed. If a player who gains no additional points and fails to complete 100 tasks has a score of 200 points, what is the value of k ?

A) 0

B) 150

C) 250

D) 400

9

A worker uses a forklift to move boxes that weigh either 40 pounds or 65 pounds each. Let x be the number of 40-pound boxes and y be the number of 65-pound boxes. The forklift can carry up to either 45 boxes or a weight of 2,400 pounds. Which of the following systems of inequalities represents this relationship?

A) $\begin{cases} 40x + 65y \le 2{,}400 \\ x + y \le 45 \end{cases}$

B) $\begin{cases} \dfrac{x}{40} + \dfrac{y}{65} \le 2{,}400 \\ x + y \le 45 \end{cases}$

C) $\begin{cases} 40x + 65y \le 45 \\ x + y \le 2{,}400 \end{cases}$

D) $\begin{cases} x + y \le 2{,}400 \\ 40x + 65y \le 2{,}400 \end{cases}$

10

A function f satisfies $f(2) = 3$ and $f(3) = 5$. A function g satisfies $g(3) = 2$ and $g(5) = 6$. What is the value of $f(g(3))$?

A) 2

B) 3

C) 5

D) 6

11

Number of hours Tony plans to read the novel per day	3
Number of parts in the novel	8
Number of chapters in the novel	239
Number of words Tony reads per minute	250
Number of pages in the novel	1,078
Number of words in the novel	349,168

Tony is planning to read a novel. The table above shows information about the novel, Tony's reading speed, and the amount of time he plans to spend reading the novel each day. If Tony reads at the rates given in the table, which of the following is closest to the number of days it would take Tony to read the entire novel?

A) 6

B) 8

C) 23

D) 324

4 ⌨ **4**

12

On January 1, 2000, there were 175,000 tons of trash in a landfill that had a capacity of 325,000 tons. Each year since then, the amount of trash in the landfill increased by 7,500 tons. If y represents the time, in years, after January 1, 2000, which of the following inequalities describes the set of years where the landfill is at or above capacity?

A) $325,000 - 7,500 \le y$

B) $325,000 \le 7,500y$

C) $150,000 \ge 7,500y$

D) $175,000 + 7,500y \ge 325,000$

13

A researcher conducted a survey to determine whether people in a certain large town prefer watching sports on television to attending the sporting event. The researcher asked 117 people who visited a local restaurant on a Saturday, and 7 people refused to respond. Which of the following factors makes it least likely that a reliable conclusion can be drawn about the sports-watching preferences of all people in the town?

A) Sample size

B) Population size

C) The number of people who refused to respond

D) Where the survey was given

14

Miles Traveled by Air Passengers in Country X, 1960 to 2005
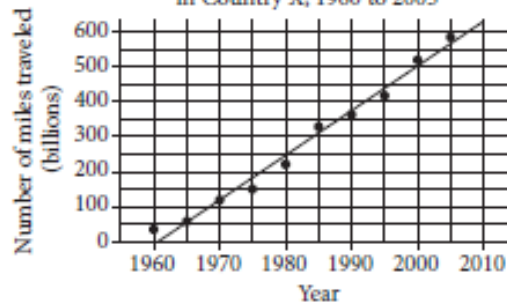
According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the number of miles traveled by air passengers in Country X was estimated to be 550 billion?

A) 1997

B) 2000

C) 2003

D) 2008

15

The distance traveled by Earth in one orbit around the Sun is about 580,000,000 miles. Earth makes one complete orbit around the Sun in one year. Of the following, which is closest to the average speed of Earth, in miles per hour, as it orbits the Sun?

A) 66,000

B) 93,000

C) 210,000

D) 420,000

16

Results on the Bar Exam of Law School Graduates

	Passed bar exam	Did not pass bar exam
Took review course	18	82
Did not take review course	7	93

The table above summarizes the results of 200 law school graduates who took the bar exam. If one of the surveyed graduates who passed the bar exam is chosen at random for an interview, what is the probability that the person chosen did not take the review course?

A) $\frac{18}{25}$

B) $\frac{7}{25}$

C) $\frac{25}{200}$

D) $\frac{7}{200}$

17

The atomic weight of an unknown element, in atomic mass units (amu), is approximately 20% less than that of calcium. The atomic weight of calcium is 40 amu. Which of the following best approximates the atomic weight, in amu, of the unknown element?

A) 8

B) 20

C) 32

D) 48

18

A survey was taken of the value of homes in a county, and it was found that the mean home value was $165,000 and the median home value was $125,000. Which of the following situations could explain the difference between the mean and median home values in the county?

A) The homes have values that are close to each other.

B) There are a few homes that are valued much less than the rest.

C) There are a few homes that are valued much more than the rest.

D) Many of the homes have values between $125,000 and $165,000.

4 🔢 **4**

Questions 19 and 20 refer to the following information.

A sociologist chose 300 students at random from each of two schools and asked each student how many siblings he or she has. The results are shown in the table below.

Students' Sibling Survey

Number of siblings	Lincoln School	Washington School
0	120	140
1	80	110
2	60	30
3	30	10
4	10	10

There are a total of 2,400 students at Lincoln School and 3,300 students at Washington School.

19

What is the median number of siblings for all the students surveyed?

A) 0

B) 1

C) 2

D) 3

20

Based on the survey data, which of the following most accurately compares the expected total number of students with 4 siblings at the two schools?

A) The total number of students with 4 siblings is expected to be equal at the two schools.

B) The total number of students with 4 siblings at Lincoln School is expected to be 30 more than at Washington School.

C) The total number of students with 4 siblings at Washington School is expected to be 30 more than at Lincoln School.

D) The total number of students with 4 siblings at Washington School is expected to be 900 more than at Lincoln School.

21

A project manager estimates that a project will take x hours to complete, where $x > 100$. The goal is for the estimate to be within 10 hours of the time it will actually take to complete the project. If the manager meets the goal and it takes y hours to complete the project, which of the following inequalities represents the relationship between the estimated time and the actual completion time?

A) $x + y < 10$

B) $y > x + 10$

C) $y < x - 10$

D) $-10 < y - x < 10$

4 ▦ **4**

Questions 22 and 23 refer to the following information.

$$I = \frac{P}{4\pi r^2}$$

At a large distance r from a radio antenna, the intensity of the radio signal I is related to the power of the signal P by the formula above.

22

Which of the following expresses the square of the distance from the radio antenna in terms of the intensity of the radio signal and the power of the signal?

A) $r^2 = \dfrac{IP}{4\pi}$

B) $r^2 = \dfrac{P}{4\pi I}$

C) $r^2 = \dfrac{4\pi I}{P}$

D) $r^2 = \dfrac{I}{4\pi P}$

23

For the same signal emitted by a radio antenna, Observer A measures its intensity to be 16 times the intensity measured by Observer B. The distance of Observer A from the radio antenna is what fraction of the distance of Observer B from the radio antenna?

A) $\dfrac{1}{4}$

B) $\dfrac{1}{16}$

C) $\dfrac{1}{64}$

D) $\dfrac{1}{256}$

24

$$x^2 + y^2 + 4x - 2y = -1$$

The equation of a circle in the xy-plane is shown above. What is the radius of the circle?

A) 2

B) 3

C) 4

D) 9

4   ▦   **4**

25

The graph of the linear function f has intercepts at $(a, 0)$ and $(0, b)$ in the xy-plane. If $a + b = 0$ and $a \neq b$, which of the following is true about the slope of the graph of f ?

A) It is positive.

B) It is negative.

C) It equals zero.

D) It is undefined.

26
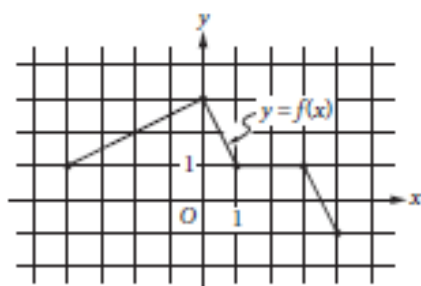
The complete graph of the function f is shown in the xy-plane above. Which of the following are equal to 1 ?

    I. $f(-4)$

    II. $f\left(\dfrac{3}{2}\right)$

    III. $f(3)$

A) III only

B) I and III only

C) II and III only

D) I, II, and III

27

Time (minutes)
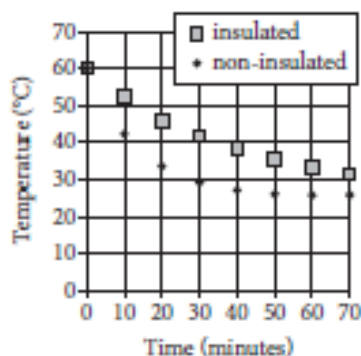
Two samples of water of equal mass are heated to 60 degrees Celsius (°C). One sample is poured into an insulated container, and the other sample is poured into a non-insulated container. The samples are then left for 70 minutes to cool in a room having a temperature of 25°C. The graph above shows the temperature of each sample at 10-minute intervals. Which of the following statements correctly compares the average rates at which the temperatures of the two samples change?

A) In every 10-minute interval, the magnitude of the rate of change of temperature of the insulated sample is greater than that of the non-insulated sample.

B) In every 10-minute interval, the magnitude of the rate of change of temperature of the non-insulated sample is greater than that of the insulated sample.

C) In the intervals from 0 to 10 minutes and from 10 to 20 minutes, the rates of change of temperature of the insulated sample are of greater magnitude, whereas in the intervals from 40 to 50 minutes and from 50 to 60 minutes, the rates of change of temperature of the non-insulated sample are of greater magnitude.

D) In the intervals from 0 to 10 minutes and from 10 to 20 minutes, the rates of change of temperature of the non-insulated sample are of greater magnitude, whereas in the intervals from 40 to 50 minutes and from 50 to 60 minutes, the rates of change of temperature of the insulated sample are of greater magnitude.

4 〔calculator〕 **4**

28
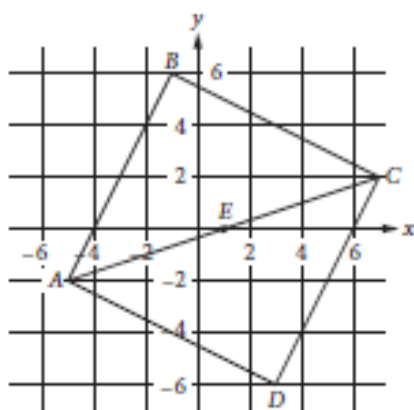
In the xy-plane above, $ABCD$ is a square and point E is the center of the square. The coordinates of points C and E are $(7,2)$ and $(1,0)$, respectively. Which of the following is an equation of the line that passes through points B and D ?

A) $y = -3x - 1$

B) $y = -3(x - 1)$

C) $y = -\dfrac{1}{3}x + 4$

D) $y = -\dfrac{1}{3}x - 1$

29
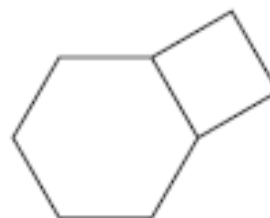
$$y = 3$$
$$y = ax^2 + b$$

In the system of equations above, a and b are constants. For which of the following values of a and b does the system of equations have exactly two real solutions?

A) $a = -2, b = 2$

B) $a = -2, b = 4$

C) $a = 2, b = 4$

D) $a = 4, b = 3$

30

The figure above shows a regular hexagon with sides of length a and a square with sides of length a. If the area of the hexagon is $384\sqrt{3}$ square inches, what is the area, in square inches, of the square?

A) 256

B) 192

C) $64\sqrt{3}$

D) $16\sqrt{3}$

4 🖩 **4**

31

A coastal geologist estimates that a certain country's beaches are eroding at a rate of 1.5 feet per year. According to the geologist's estimate, how long will it take, in years, for the country's beaches to erode by 21 feet?

32

If h hours and 30 minutes is equal to 450 minutes, what is the value of h ?

33

In the xy-plane, the point $(3, 6)$ lies on the graph of the function $f(x) = 3x^2 - bx + 12$. What is the value of b ?

34

In one semester, Doug and Laura spent a combined 250 hours in the tutoring lab. If Doug spent 40 more hours in the lab than Laura did, how many hours did Laura spend in the lab?

4 🖩 **4**

35

$$a = 18f + 15$$

Jane made an initial deposit to a savings account. Each week thereafter she deposited a fixed amount to the account. The equation above models the amount a, in dollars, that Jane has deposited after f weekly deposits. According to the model, how many dollars was Jane's initial deposit? (Disregard the $ sign when gridding your answer.)

36
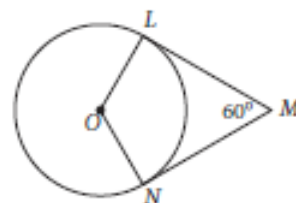
In the figure above, point O is the center of the circle, line segments LM and MN are tangent to the circle at points L and N, respectively, and the segments intersect at point M as shown. If the circumference of the circle is 96, what is the length of minor arc $\overset{\frown}{LN}$?

Questions 37 and 38 refer to the following information.

A botanist is cultivating a rare species of plant in a controlled environment and currently has 3000 of these plants. The population of this species that the botanist expects to grow next year, $N_{next\ year}$, can be estimated from the number of plants this year, $N_{this\ year}$, by the equation below.

$$N_{next\ year} = N_{this\ year} + 0.2\left(N_{this\ year}\right)\left(1 - \frac{N_{this\ year}}{K}\right)$$

The constant K in this formula is the number of plants the environment is able to support.

37

According to the formula, what will be the number of plants two years from now if $K = 4000$? (Round your answer to the nearest whole number.)

38

The botanist would like to increase the number of plants that the environment can support so that the population of the species will increase more rapidly. If the botanist's goal is that the number of plants will increase from 3000 this year to 3360 next year, how many plants must the modified environment support?

Appendix D – Posttest

3   3

Math Test – No Calculator
25 MINUTES, 20 QUESTIONS

Turn to Section 3 of your answer sheet to answer the questions in this section.

DIRECTIONS

For questions 1-15, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 16-20,** solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 16 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

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4. All figures lie in a plane unless otherwise indicated.
5. Unless otherwise indicated, the domain of a given function f is the set of all real numbers x for which $f(x)$ is a real number.
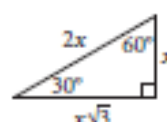
REFERENCE

$A = \pi r^2$
$C = 2\pi r$

$A = \ell w$
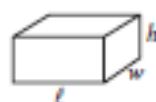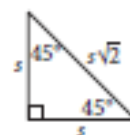
$A = \frac{1}{2}bh$

$c^2 = a^2 + b^2$

Special Right Triangles

$V = \ell wh$

$V = \pi r^2 h$

$V = \frac{4}{3}\pi r^3$

$V = \frac{1}{3}\pi r^2 h$

$V = \frac{1}{3}\ell wh$

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

1

Which of the following expressions is equal to 0 for some value of x ?

A) $|x-1|-1$

B) $|x+1|+1$

C) $|1-x|+1$

D) $|x-1|+1$

2

$$f(x) = \frac{3}{2}x + b$$

In the function above, b is a constant. If $f(6) = 7$, what is the value of $f(-2)$?

A) −5

B) −2

C) 1

D) 7

3

$$\frac{x}{y} = 6$$
$$4(y+1) = x$$

If (x, y) is the solution to the system of equations above, what is the value of y ?

A) 2

B) 4

C) 12

D) 24

4

If $f(x) = -2x + 5$, what is $f(-3x)$ equal to?

A) $-6x-5$

B) $6x+5$

C) $6x-5$

D) $6x^2 - 15x$

5

$$3(2x + 1)(4x + 1)$$

Which of the following is equivalent to the expression above?

A) $45x$

B) $24x^2 + 3$

C) $24x^2 + 18x + 3$

D) $18x^2 + 6$

6

If $\dfrac{a-b}{b} = \dfrac{3}{7}$, which of the following must also be true?

A) $\dfrac{a}{b} = -\dfrac{4}{7}$

B) $\dfrac{a}{b} = \dfrac{10}{7}$

C) $\dfrac{a+b}{b} = \dfrac{10}{7}$

D) $\dfrac{a-2b}{b} = -\dfrac{11}{7}$

7

While preparing to run a marathon, Amelia created a training schedule in which the distance of her longest run every week increased by a constant amount. If Amelia's training schedule requires that her longest run in week 4 is a distance of 8 miles and her longest run in week 16 is a distance of 26 miles, which of the following best describes how the distance Amelia runs changes between week 4 and week 16 of her training schedule?

A) Amelia increases the distance of her longest run by 0.5 miles each week.

B) Amelia increases the distance of her longest run by 2 miles each week.

C) Amelia increases the distance of her longest run by 2 miles every 3 weeks.

D) Amelia increases the distance of her longest run by 1.5 miles each week.

8

Which of the following equations represents a line that is parallel to the line with equation $y = -3x + 4$?

A) $6x + 2y = 15$

B) $3x - y = 7$

C) $2x - 3y = 6$

D) $x + 3y = 1$

9

$$\sqrt{x-a} = x - 4$$

If $a = 2$, what is the solution set of the equation above?

A) $\{3, 6\}$

B) $\{2\}$

C) $\{3\}$

D) $\{6\}$

10

If $\dfrac{t+5}{t-5} = 10$, what is the value of t ?

A) $\dfrac{45}{11}$

B) 5

C) $\dfrac{11}{2}$

D) $\dfrac{55}{9}$

11

$$x = 2y + 5$$

$$y = (2x - 3)(x + 9)$$

How many ordered pairs (x, y) satisfy the system of equations shown above?

A) 0

B) 1

C) 2

D) Infinitely many

3 ⊠ **3**

12

Ken and Paul each ordered a sandwich at a restaurant. The price of Ken's sandwich was x dollars, and the price of Paul's sandwich was $1 more than the price of Ken's sandwich. If Ken and Paul split the cost of the sandwiches evenly and each paid a 20% tip, which of the following expressions represents the amount, in dollars, each of them paid? (Assume there is no sales tax.)

A) $0.2x + 0.2$

B) $0.5x + 0.1$

C) $1.2x + 0.6$

D) $2.4x + 1.2$

13
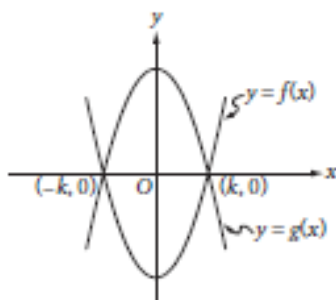
The functions f and g, defined by $f(x) = 8x^2 - 2$ and $g(x) = -8x^2 + 2$, are graphed in the xy-plane above. The graphs of f and g intersect at the points $(k, 0)$ and $(-k, 0)$. What is the value of k ?

A) $\dfrac{1}{4}$

B) $\dfrac{1}{2}$

C) 1

14

$$\frac{8 - i}{3 - 2i}$$

If the expression above is rewritten in the form $a + bi$, where a and b are real numbers, what is the value of a ? (Note: $i = \sqrt{-1}$)

A) 2

B) $\dfrac{8}{3}$

C) 3

D) $\dfrac{11}{3}$

15

$$x^2 - \frac{k}{2}x = 2p$$

In the quadratic equation above, k and p are constants. What are the solutions for x ?

A) $x = \dfrac{k}{4} \pm \dfrac{\sqrt{k^2 + 2p}}{4}$

B) $x = \dfrac{k}{4} \pm \dfrac{\sqrt{k^2 + 32p}}{4}$

C) $x = \dfrac{k}{2} \pm \dfrac{\sqrt{k^2 + 2p}}{2}$

D) $x = \dfrac{k}{2} \pm \dfrac{\sqrt{k^2 + 32p}}{4}$
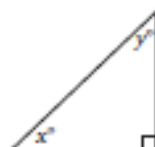
16

2x   shelf

shampoo

3x   18 in

shelf

shelf

x

Jim has a triangular shelf system that attaches to his showerhead. The total height of the system is 18 inches, and there are three parallel shelves as shown above. What is the maximum height, in inches, of a shampoo bottle that can stand upright on the middle shelf?

17

In the triangle above, the sine of $x°$ is 0.6. What is the cosine of $y°$?

18

$$x^3 - 5x^2 + 2x - 10 = 0$$

For what real value of x is the equation above true?

19

$$-3x + 4y = 20$$
$$6x + 3y = 15$$

If (x, y) is the solution to the system of equations above, what is the value of x ?

20

The mesosphere is the layer of Earth's atmosphere between 50 kilometers and 85 kilometers above Earth's surface. At a distance of 50 kilometers from Earth's surface, the temperature in the mesosphere is $-5°$ Celsius, and at a distance of 80 kilometers from Earth's surface, the temperature in the mesosphere is $-80°$ Celsius. For every additional 10 kilometers from Earth's surface, the temperature in the mesosphere decreases by $k°$ Celsius, where k is a constant. What is the value of k ?

4 🖩 4

Math Test – Calculator
55 MINUTES, 38 QUESTIONS

Turn to Section 4 of your answer sheet to answer the questions in this section.

DIRECTIONS

For questions 1-30, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. **For questions 31-38,** solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 31 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.
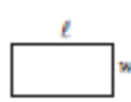
NOTES

1. The use of a calculator **is permitted**.

2. All variables and expressions used represent real numbers unless otherwise indicated.

3. Figures provided in this test are drawn to scale unless otherwise indicated.

4. All figures lie in a plane unless otherwise indicated.

5. Unless otherwise indicated, the domain of a given function f is the set of all real numbers x for which $f(x)$ is a real number.
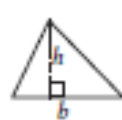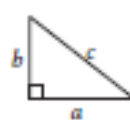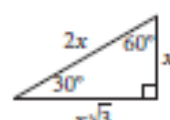
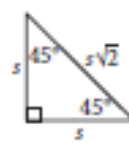### REFERENCE

$A = \pi r^2$ $A = \ell w$ $A = \frac{1}{2}bh$ $c^2 = a^2 + b^2$ Special Right Triangles
$C = 2\pi r$

$V = \ell wh$ $V = \pi r^2 h$ $V = \frac{4}{3}\pi r^3$ $V = \frac{1}{3}\pi r^2 h$ $V = \frac{1}{3}\ell wh$

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

4 🖩 **4**

1

The monthly membership fee for an online television and movie service is $9.80. The cost of viewing television shows online is included in the membership fee, but there is an additional fee of $1.50 to rent each movie online. For one month, Jill's membership and movie rental fees were $12.80. How many movies did Jill rent online that month?

A) 1

B) 2

C) 3

D) 4

2

One of the requirements for becoming a court reporter is the ability to type 225 words per minute. Donald can currently type 180 words per minute, and believes that with practice he can increase his typing speed by 5 words per minute each month. Which of the following represents the number of words per minute that Donald believes he will be able to type m months from now?

A) $5 + 180m$

B) $225 + 5m$

C) $180 + 5m$

D) $180 - 5m$

3

If a 3-pound pizza is sliced in half and each half is sliced into thirds, what is the weight, in ounces, of each of the slices? (1 pound = 16 ounces)

A) 4

B) 6

C) 8

D) 16

4

Nick surveyed a random sample of the freshman class of his high school to determine whether the Fall Festival should be held in October or November. Of the 90 students surveyed, 25.6% preferred October. Based on this information, about how many students in the entire 225-person class would be expected to prefer having the Fall Festival in October?

A) 50

B) 60

C) 75

D) 80

5

The density of an object is equal to the mass of the object divided by the volume of the object. What is the volume, in milliliters, of an object with a mass of 24 grams and a density of 3 grams per milliliter?

A) 0.125

B) 8

C) 21

D) 72

6

Last week Raul worked 11 more hours than Angelica. If they worked a combined total of 59 hours, how many hours did Angelica work last week?

A) 24

B) 35

C) 40

D) 48

7

Movies with Greatest Ticket Sales in 2012

MPAA rating	Type of movie				
	Action	Animated	Comedy	Drama	Total
PG	2	7	0	2	11
PG-13	10	0	4	8	22
R	6	0	5	6	17
Total	18	7	9	16	50

The table above represents the 50 movies that had the greatest ticket sales in 2012, categorized by movie type and Motion Picture Association of America (MPAA) rating. What proportion of the movies are comedies with a PG-13 rating?

A) $\dfrac{2}{25}$

B) $\dfrac{9}{50}$

C) $\dfrac{2}{11}$

D) $\dfrac{11}{25}$

8

Line ℓ in the xy-plane contains points from each of Quadrants II, III, and IV, but no points from Quadrant I. Which of the following must be true?

A) The slope of line ℓ is undefined.

B) The slope of line ℓ is zero.

C) The slope of line ℓ is positive.

D) The slope of line ℓ is negative.

4 🧮 **4**

Number of Registered Voters
in the United States in 2012, in Thousands

Region	Age, in years					Total
	18 to 24	25 to 44	45 to 64	65 to 74	75 and older	
Northeast	2,713	8,159	10,986	3,342	2,775	27,975
Midwest	3,453	11,237	13,865	4,221	3,350	36,126
South	5,210	18,072	21,346	7,272	4,969	56,869
West	3,390	10,428	11,598	3,785	2,986	32,187
Total	14,766	47,896	57,795	18,620	14,080	153,157

The table above shows the number of registered voters in 2012, in thousands, in four geographic regions and five age groups. Based on the table, if a registered voter who was 18 to 44 years old in 2012 is chosen at random, which of the following is closest to the probability that the registered voter was from the Midwest region?

A) 0.10

B) 0.25

C) 0.40

D) 0.75

4 🖩 **4**

Gestation Period versus Life Expectancy
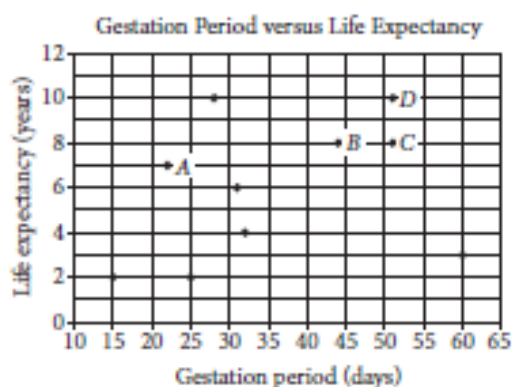
A curator at a wildlife society created the scatterplot
above to examine the relationship between the gestation
period and life expectancy of 10 species of animals.

10

What is the life expectancy, in years, of the animal
that has the longest gestation period?

A) 3

B) 4

C) 8

D) 10

11

Of the labeled points, which represents the animal
for which the ratio of life expectancy to gestation
period is greatest?

A) *A*

B) *B*

C) *C*

D) *D*

12

In the *xy*-plane, the graph of function *f* has
x-intercepts at −3, −1, and 1. Which of the
following could define *f* ?

A) $f(x) = (x-3)(x-1)(x+1)$

B) $f(x) = (x-3)(x-1)^2$

C) $f(x) = (x-1)(x+1)(x+3)$

D) $f(x) = (x+1)^2(x+3)$

13

The population of mosquitoes in a swamp is estimated over the course of twenty weeks, as shown in the table.

Time (weeks)	Population
0	100
5	1,000
10	10,000
15	100,000
20	1,000,000

Which of the following best describes the relationship between time and the estimated population of mosquitoes during the twenty weeks?

A) Increasing linear

B) Decreasing linear

C) Exponential growth

D) Exponential decay

14

$$1,000\left(1 + \frac{r}{1,200}\right)^{12}$$

The expression above gives the amount of money, in dollars, generated in a year by a $1,000 deposit in a bank account that pays an annual interest rate of r %, compounded monthly. Which of the following expressions shows how much additional money is generated at an interest rate of 5% than at an interest rate of 3% ?

A) $1,000\left(1 + \dfrac{5-3}{1,200}\right)^{12}$

B) $1,000\left(1 + \dfrac{\frac{5}{3}}{1,200}\right)^{12}$

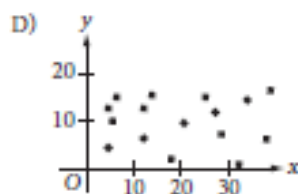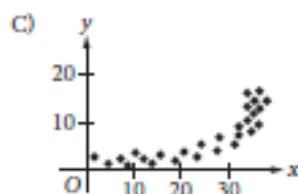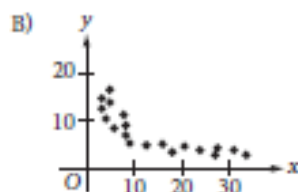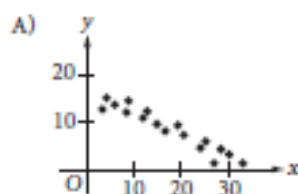C) $\dfrac{1,000\left(1 + \dfrac{5}{1,200}\right)^{12}}{1,000\left(1 + \dfrac{3}{1,200}\right)^{12}}$

D) $1,000\left(1 + \dfrac{5}{1,200}\right)^{12} - 1,000\left(1 + \dfrac{3}{1,200}\right)^{12}$

15

Which of the following scatterplots shows a relationship that is appropriately modeled with the equation $y = ax^b$, where a is positive and b is negative?

A)

B)

C)

D)

Questions 16 and 17 refer to the following information.

Mr. Martinson is building a concrete patio in his backyard and deciding where to buy the materials and rent the tools needed for the project. The table below shows the materials' cost and daily rental costs for three different stores.

Store	Materials' Cost, M (dollars)	Rental cost of wheelbarrow, W (dollars per day)	Rental cost of concrete mixer, K (dollars per day)
A	750	15	65
B	600	25	80
C	700	20	70

The total cost, y, for buying the materials and renting the tools in terms of the number of days, x, is given by $y = M + (W + K)x$.

16

For what number of days, x, will the total cost of buying the materials and renting the tools from Store B be less than or equal to the total cost of buying the materials and renting the tools from Store A ?

A) $x \le 6$

B) $x \ge 6$

C) $x \le 7.3$

D) $x \ge 7.3$

4 ⚃ **4**

17

If the relationship between the total cost, y, of buying the materials and renting the tools at Store C and the number of days, x, for which the tools are rented is graphed in the xy-plane, what does the slope of the line represent?

A) The total cost of the project

B) The total cost of the materials

C) The total daily cost of the project

D) The total daily rental costs of the tools

18

Jim has identical drinking glasses each in the shape of a right circular cylinder with internal diameter of 3 inches. He pours milk from a gallon jug into each glass until it is full. If the height of milk in each glass is about 6 inches, what is the largest number of full milk glasses that he can pour from one gallon of milk? (Note: There are 231 cubic inches in 1 gallon.)
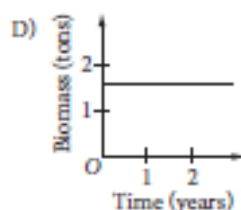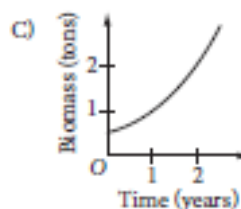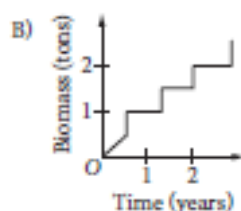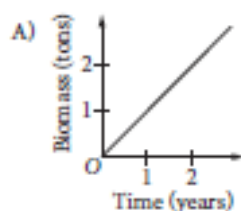
A) 2

B) 4

C) 5

D) 6

19

If $3p - 2 \geq 1$, what is the least possible value of $3p + 2$?
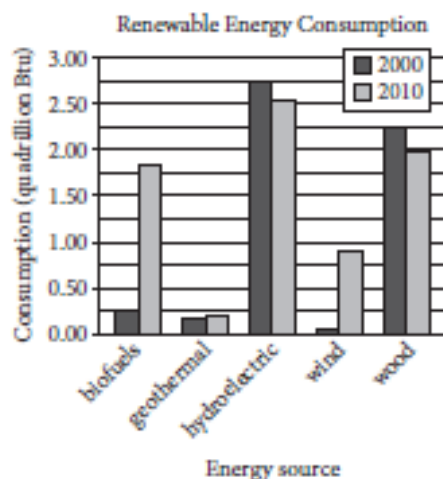
A) 5

B) 3

C) 2

D) 1

20

The mass of living organisms in a lake is defined to be the biomass of the lake. If the biomass in a lake doubles each year, which of the following graphs could model the biomass in the lake as a function of time? (Note: In each graph below, O represents $(0,0)$.)

A)

B)

C)

D)

Questions 21 and 22 refer to the following information.

Renewable Energy Consumption

The bar graph above shows renewable energy consumption in quadrillions of British thermal units (Btu) in the United States, by energy source, for several energy sources in the years 2000 and 2010.

21

In a scatterplot of this data, where renewable energy consumption in the year 2000 is plotted along the x-axis and renewable energy consumption in the year 2010 is plotted along the y-axis for each of the given energy sources, how many data points would be above the line $y = x$?

A) 1

B) 2

C) 3

D) 4

4 **4**

22

Of the following, which best approximates the percent decrease in consumption of wood power in the United States from 2000 to 2010 ?

A)   6%

B)   11%

C)   21%

D)   26%

23

The tables below give the distribution of high temperatures in degrees Fahrenheit (°F) for City A and City B over the same 21 days in March.

City A

Temperature (°F)	Frequency
80	3
79	14
78	2
77	1
76	1

City B

| Temperature (°F)	Frequency
80	6
79	3
78	2
77	4
76	6

Which of the following is true about the data shown for these 21 days?

A) The standard deviation of temperatures in City A is larger.

B) The standard deviation of temperatures in City B is larger.

C) The standard deviation of temperatures in City A is the same as that of City B.

D) The standard deviation of temperatures in these cities cannot be calculated with the data provided.

27

The relative housing cost for a US city is defined to be the ratio $\dfrac{\text{average housing cost for the city}}{\text{national average housing cost}}$, expressed as a percent.
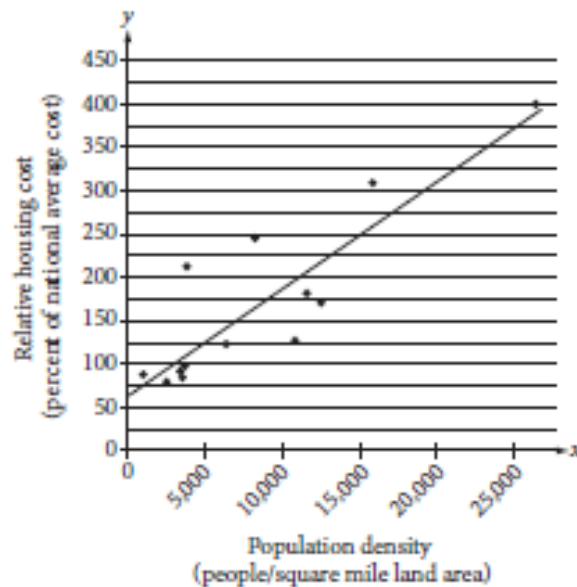
The scatterplot above shows the relative housing cost and the population density for several large US cities in the year 2005. The line of best fit is also shown and has equation $y = 0.0125x + 61$. Which of the following best explains how the number 61 in the equation relates to the scatterplot?

A) In 2005, the lowest housing cost in the United States was about $61 per month.

B) In 2005, the lowest housing cost in the United States was about 61% of the highest housing cost.

C) In 2005, even in cities with low population densities, housing costs were never below 61% of the national average.

D) In 2005, even in cities with low population densities, housing costs were likely at least 61% of the national average.

B) I and II only

C) I and III only

D) I, II, and III

4 🖩 **4**

28

$$f(x) = (x + 6)(x - 4)$$

Which of the following is an equivalent form of the function f above in which the minimum value of f appears as a constant or coefficient?

A) $f(x) = x^2 - 24$

B) $f(x) = x^2 + 2x - 24$

C) $f(x) = (x - 1)^2 - 21$

D) $f(x) = (x + 1)^2 - 25$

29

If x is the average (arithmetic mean) of m and 9, y is the average of $2m$ and 15, and z is the average of $3m$ and 18, what is the average of x, y, and z in terms of m ?

A) $m + 6$

B) $m + 7$

C) $2m + 14$

D) $3m + 21$

30
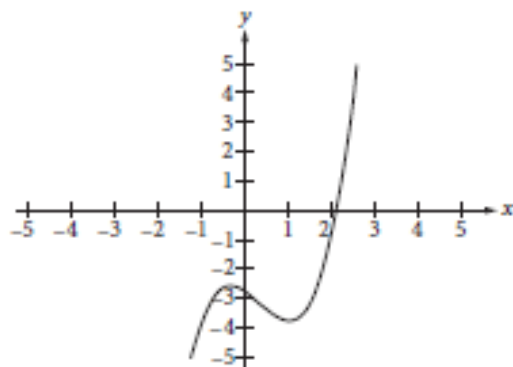
The function $f(x) = x^3 - x^2 - x - \dfrac{11}{4}$ is graphed in the xy-plane above. If k is a constant such that the equation $f(x) = k$ has three real solutions, which of the following could be the value of k ?

A) 2

B) 0

C) −2

D) −3

31

A partially filled pool contains 600 gallons of water. A hose is turned on, and water flows into the pool at the rate of 8 gallons per minute. How many gallons of water will be in the pool after 70 minutes?

32

The normal systolic blood pressure P, in millimeters of mercury, for an adult male x years old can be modeled by the equation $P = \dfrac{x + 220}{2}$. According to the model, for every increase of 1 year in age, by how many millimeters of mercury will the normal systolic blood pressure for an adult male increase?

33

The *pes*, a Roman measure of length, is approximately equal to 11.65 inches. It is also equivalent to 16 smaller Roman units called digits. Based on these relationships, 75 Roman digits is equivalent to how many feet, to the nearest hundredth? (12 inches = 1 foot)

34

In a study of bat migration habits, 240 male bats and 160 female bats have been tagged. If 100 more female bats are tagged, how many more male bats must be tagged so that $\dfrac{3}{5}$ of the total number of bats in the study are male?

35

$$q = \frac{1}{2}nv^2$$

The dynamic pressure q generated by a fluid moving with velocity v can be found using the formula above, where n is the constant density of the fluid. An aeronautical engineer uses the formula to find the dynamic pressure of a fluid moving with velocity v and the same fluid moving with velocity $1.5v$. What is the ratio of the dynamic pressure of the faster fluid to the dynamic pressure of the slower fluid?

36
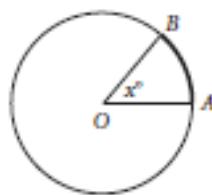
Note: Figure not drawn to scale.

In the figure above, the circle has center O and has radius 10. If the length of arc $\overset{\frown}{AB}$ (shown in bold) is between 5 and 6, what is one possible integer value of x ?

Questions 37 and 38 refer to the following information.

The stock price of one share in a certain company is worth $360 today. A stock analyst believes that the stock will lose 28 percent of its value each week for the next three weeks. The analyst uses the equation $V = 360(r)^t$ to model the value, V, of the stock after t weeks.

37

What value should the analyst use for r ?

38

To the nearest dollar, what does the analyst believe the value of the stock will be at the end of three weeks? (Note: Disregard the $ sign when gridding your answer.)

Appendix E - Letter of Cooperation for Data Collection in Schools

Date: February, 2015

Dear _____,

     I, Khalid Mohammed Diab as a graduate student in the Curriculum & Instruction Department at United Arab Emirates University, I am conducting research as part of the requirements for a Master Degree in Education. Under the supervision of Dr. Adeeb Jarrah. The Purpose of this letter to ask for permission to conduct the study. The title of my research project is:

     "AN INVESTIGATION INTO THE EFFECT OF FLIPPED CLASSROOM ON STUDENTS' ACHIEVEMENT IN THE NEW 2016 SCHOLASTIC ASSESSMENT TEST MATHEMATICS SKILLS IN THE UNITED ARAB EMIRATES".

     The purpose of my research is to evaluate the flipped classroom implementation on student academic achievement In SAT 2016 Skills, to: increases student responsibility for their learning, increases opportunity for higher-order thinking skills, increases contact time with students for SAT training, and to Maximizes learning opportunities even when absent.I am writing to request your permission to conduct my research in _____in Four Mathematics classrooms. The study will take approximately six weeks. Data will be collected at the beginning and the end of the study and will involve a student pretest and a student posttest. Participate in this study will be grade 11 core students, two classes (one HST and one AE) in the control group (normal teaching methods occur) and another two classes (one HST and one AE) will be in experimental group the flipped classroom instruction. The flipped classroom teacher will be expected to "flip" the classroom by allowing students prepare their lesson, study, and complete classwork at home (via teacher made videos, Khan Academy videos, or any other media which contain the content to be learned by students (all media will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, practice more or extend learning through further investigation or application problems. The data collected will be used to addresses students' deficiencies in high school mathematics SAT skills and investigate whether the flipped classroom method will encourage student academic achievement and impact student critical thinking skills in the secondary mathematics classroom. Participants will be presented with informed consent information prior to participating. Taking part in this study the **confidentiality and privacy of the research result, the use of data will be for research and for supporting the students with the best teaching methods to improve their score in SAT Exam.**

The teaching videos material will be related to the following Skills in New SAT skills:

    1-   Heart of Algebra
    2-   Problem Solving and Data Analysis
    3-   Passport to Advanced Math

On behalf of _____ , I _____

have no objection for conducting this study in _____

Name:

Signature:

Appendix F – List of Heart of Algebra videos

Number of videos provided in the Heart of Algebra Skills

Heart of Algebra Skill	Number of videos From Khan Academy	Number of teacher made videos
Solving Linear equations and Inequalities	2	3
Interpreting Linear functions	2	2
Linear equations and Linear Inequalities word problems	3	2
Graphing Linear equations	2	1
Linear function word problems	2	2
System of linear equations and inequalities	5	2
Total number of videos	16	12
Total		28

Appendix G – List of Problem Solving videos

Number of videos provided in the Problem Solving and Data analysis Skills

Problem Solving Skills	Number of videos From Khan Academy	Number of teacher made videos
Ratio , Rates , Proportions , percent , and units	6	1
Table Data and scatter plots	4	2
Key features of the graphs	1	1
Linear and exponential growth	2	1
Data inferences	2	2
Spread and slope distribution	2	1
Data collection	2	1
Total number of videos	19	9
Total		28

Appendix H – List of Passport to Advanced Math videos

Number of videos provided in the Passport to Advanced Math Skills

Advanced Math Skills	Number of videos From Khan Academy	Number of teacher made videos
Solving Quadratic equations	2	0
Interpreting Non Linear expressions	2	0
Quadratic and exponential expressions and word problems	4	0
Radical and rational exponents	6	0
Operations with polynomials and polynomial graph	4	0
Nonlinear equations Graphs	2	0
Linear and quadratic system	2	0
Structure in expressions	2	0
Isolating quantities	2	0
Function notation	2	0
Total number of videos	28	0