AC 2010-1846: WHO NEEDS ANOTHER APPLIED MATHEMATICS COURSE?

John Heublein, Kansas State University, Salina

Kenneth Barnard, Kansas State University, Salina

© American Society for Engineering Education, 2010

Who Needs Another Applied Mathematics Course?

ABSTRACT

Aviation mathematics has been used for years and hence is not a new topic for discussion. In the digital-age and with millennial students it is time to revisit the methods of pedagogy. Because students have always had different learning styles this paper outlines an instructional approach that addresses the declining mathematical skill level of the entering freshman students. Our hypothesis states, "The researchers have observed students entering the Professional Pilot program at Kansas State University at Salina lack the necessary prerequisite mathematics skills for success in subsequent higher mathematics courses. Using an introductory applied mathematics course coupled with applied aviation exercises and engaging pedagogical methods in mathematics courses could engage students and enhance their mathematics learning skills." A fall 2009 Kansas State University at Salina (KSU-S) aviation faculty survey, albeit small, supports this hypothesis.

The researchers' observed presumption is that present day students possess more technology understanding and rely on audio/visual feedback stimuli. One approach modifies methods of instruction to accommodate this mode of learning in particular with professional pilot aviation students. The classroom presentation format must include a pedagogy that increases the student's motivation through visualization of the learning outcomes to create a richer and more stimulating learning environment. Millennial generation learning styles also seem to respond to pedagogies that visually tell a story personally applicable to them.

A challenge exists to provide meaningful student learning outcomes and increase mathematical knowledge while meeting millennial students' expectations. We start by demonstrating a working knowledge of arithmetic, algebra, basic trigonometry, know how to organize data to arrive at solutions to various exercises and then apply practical problems involving aviation application exercises.

Assessments for an aviation mathematics class include completion of homework assignments, examinations, and oral/written reports over the use of mathematics in aviation. We also believe peer reviews from outside the mathematics and aviation departments provide another supportive assessment tool for evaluating the instruction and student experience.

By focusing on a separate aviation mathematics course with a personalized teaching pedagogy that meets the learning styles of millennial students, we hope students will realize and better understand mathematics concepts needed in their aviation careers.

Provisions for extra training will enhance a higher mathematical level of the student. An increase in the mathematical level of the student will subsequently lead to an increase in student understanding of the mathematical concepts and therefore an increase in successful completion of the course.

Introduction

Background of the problem:

Aviation mathematics training became popular in the 1940's during and after World War II with textbooks titled "Aviation Mathematics" published on the subject by the Bruce Publishing Company, Milwaukee, Wisconsin[1] and the "Royal Air Force" for members of the British Air Training Corps[2]. These textbooks generally covered basic mathematics, algebra, and trigonometry. The traditional engineering trigonometry course constitutes part of the required professional pilot program curriculum. Below is a short list of content topics covered in traditional engineering trigonometry courses that have little relevancy to an individual becoming a successful pilot:

- Trigonometry Identities,
- The Addition and Subtraction Formulas,
- Multiple-Angle Formulas,
- Trigonometric Form for Complex Numbers, and
- De Moivre's Theorem and nth Roots of Complex Numbers

An extremely low number of the present exercises in the traditional engineering trigonometry courses are specifically aviation oriented which further compounds the issue of relevance.

Researcher involvement:

Professor John Heublein has taught intermediate algebra, college algebra, trigonometry, and calculus to professional pilot students at K-State at Salina for thirty years. In that time, he has witnessed the decline of mathematics preparation of entering freshman. Professor Heublein recently experienced firsthand the lack of motivation of these students in their professional pilot degree program's required mathematics courses. John has a direct interest in finding a pedagogical approach that will excite students to learn. John attended a breakout session held during the 2007 conference by the International Council on Technology in Collegiate Mathematics (ICTCM) where mathematics classes and millennial students were topics discussed. This led to a K-State at Salina campus wide panel discussion, led by Professor Heublein, on millennial college students. One pedagogical challenge discussed was meeting the course content expectations of the mathematics department on the main campus while still seamlessly teaching an engineering trigonometry course to aviation students. This group of students will not use most of the mathematics material and skills developed which are necessary to successfully complete this course. The workshop and the panel discussion have continued to stimulate an interest and curiosity among the mathematics faculty at K-State at Salina. What must the mathematics faculty do to teach the plane trigonometry course and meet the expectations of the professional pilot student?

Professor Ken Barnard has been teaching aviation courses at the college for thirty-three years and has developed remedial application mathematics courses in the past to bring entering aviation freshman students to an acceptable level of competence for successful outcomes completion in college algebra. This remedial approach acts as a stopgap and does not address the full affect of the stated hypothesis because continued motivation and interest in the subject is not fully addressed.

Flying involves a technical, gadget-filled environment where use of the full knowledge base of the pilot routinely makes critical decisions that affect life and death outcomes. If the knowledge is not learned and incomplete or misunderstood information is used in the aeronautical decision

making process, then resulting decisions become flawed. All educators have a stake in producing fully trained professional pilots.

Problem:

The students told Professor Heublein they enjoy the trigonometry class much more when he modifies the exercises to involve aviation terminology and applications. They become aware of a connection or relevance to their chosen profession. The course exercises must therefore be developed and presented in a pedagogical manner that makes use of a language and terminology that engages the aviation student. The professor teaching the traditional engineering trigonometry course has the challenge to create pedagogical relevant exercises to engage the students in the learning process.

Purpose:

The purpose of this paper is to present a case for the development and institution of an applied mathematics course that includes the study of arithmetic, algebra, geometry, and trigonometry from the aviation point-of-view. A course of this nature will provide more engaging activities and exercises for the aviation students, which the researchers believe will lead to understanding the relevancy and importance of a solid background in mathematics. Moreover, this knowledge is necessary for aviation students to attain success in their aviation careers. The researchers desire to create a learning environment and meaningful course for the students. They not only want to teach the content of the courses to be understandable and meaningful, but also enhance the ability of the students to develop and process the current information to formulate new ideas, concepts, and use in subsequent courses. "Learning is not just a process of taking in new information, ideas, and skills, but the new material is reconstructed by the mind."[9] By engaging and motivating the students, they will not only attain academic success but will develop a sense for lifelong learning.

Hypothesis: Based on the observation of these two researchers, students entering the Professional Pilot program at Kansas State University at Salina lack the necessary prerequisite mathematics skills for success in subsequent higher mathematics courses. Using an introductory applied math

course with exercises and appropriate pedagogy methods, in all mathematics courses, will engage students and enhance their mathematics learning skills.

Assumptions: Over sixty years of combined teaching experience is used qualitatively in observing student mathematics preparations and motivation changes over time. From experience, we have also tried different pedagogy methods, have agreement that the current "millennial" students are visual learners with technical shrewdness, and prefer active engagement activities.

Limitations of study: We have a small faculty, N = eight, in the K-State at Salina aviation department, therefore the data survey collected is very small and lacks validity. Having said that, these two faculty members have broad based observation level experience, as well as depth of experience. The faculty survey (Attachment #1) supports the stated hypothesis.

Review of the literature:

There has been an abundance of discussion and materials presented in academia about the millennial student, who was born between 1982 and 2003. The researchers, through multiple sources of professional literature of higher education, note the millennial student has created a sense of frustration in today's educators. An earlier study done on this campus about Kansas State Online course tools clearly revealed a student driven request for the use of online tools in their courses.[8] These students identified the top ten features that enhanced their learning such as posting grades and posting assignments on the course calendar (top two). Students want instructors to be able to keep online material postings current and to be organized (top two). Ann Phillips, at a KSU faculty retreat in 2004, cited the top ten things students wish you'd remember about teaching; Organized; "office hours…be there", have a sense of audience: "we are more than drunken fools", and "give teaching life" (top three).[8] Millennial students are comfortable with technology and in some instances more so than their professors. Most of them have a cell phone, have access to a computer, and have been accustomed to surfing all types of URL sites for the most part of their lives. They also have experience text-messaging and playing video games. They have developed considerable experience in social interaction through MySpace, Twitter, blogs, and Facebook. With their access to and use of computers, pagers and cell phones, they have keenly mastered the ability to multitask.[7] Oblinger states that some of the characteristics exhibited by the millennials include:

- Gravitate toward group activity;
- Spend more time doing homework and housework and less time watching TV;
- Believe "it's cool to be smart";
- Are fascinated by new technologies.[3]

The millennials have become accustomed to having access to instant information and conveniences, which has carried over to academia. Many students expect instant gratification from their professors in terms of getting their papers back graded and getting instant responses to their e-mails, voice mails, etc.[4]

Even though possessing these desired characteristics, "some researchers also fear that millennial students, being over-reliant on communications technology, will have stunted interpersonal (face-to-face) skills. Others have expressed similar concerns that the ease with which millennial students routinely engage in multitasking behaviors, enabled in part using technology, has shortened their collective attention span. Finally, having completed primary and secondary curricula that may unintentionally encourage rote learning, these students may lack the skills necessary to be critical thinkers or demonstrate introspection and self-reflection."[5]

"Millennial students are inclined to be more academically disengaged than past generations. While millennials have been getting higher grades than ever before, they lack connection with the material and spend much less time studying than students from past generations. This suggests that this change is partly due to an emphasis on end products rather than the methods of achieving them."[6] Millennials tend to focus on rapidly completing assignments rather than understanding the process and developing the ability to transfer their newfound knowledge to solving exercises that are more complex.

There appears to be a conflict in the research conducted by Oblinger in 2003 and the research conducted by Virginia Tech University in 2006. Oblinger contends the millennials spend more time doing homework; whereas, the research at Virginia Tech University contends the millennials are more academically disengaged. The contradictions between the two studies

suggest that not only more research must be conducted, but also characteristics of the survey audiences might differ from locale to locale.

It is observed that today's students are somewhat impatient because of their desire for instant gratification. Because of their desire for instant "answers", they exhibit a lack of patience for using different methods or approaches to arrive at an exercise solution. Some students will not take the extra time to study or work through detailed solutions of textbook examples or review their class notes, which explain the procedure to successfully do or complete an exercise. They decide this would be a good class exercise for the professor. The substance of education to them differs from their professors. They arrive on campus with a sense of entitlement. They sometimes consider studying and completing homework assignments as optional. They often ask, "Why do I need to know this or when will I ever use this in my field of study?" Educators become frustrated and believe the students lack motivation. To compensate for the perceived students' lack of effort to achieve success in the class, the amount of work required of the students is sometimes increased. Some educators believe this maneuver may increase the student's mastery of the material. The necessity of the students' not only hearing the words of the professor but also understanding the words of the professor is imperative. It must also be emphasized the importance of the professor understanding what is being told to the students. The professor and student need to be on the same page, which will lead to a better understanding of the presented material, develop the student's self-confidence in mathematics, and actively engage the students in the class, which enhances the learning atmosphere.

Growing up in this cultural environment has instilled in millennial students a number of positive qualities. Howe suggests, "These students have been socialized by supportive parents to be successful in life. They have engaged in numerous academic, extracurricular, and service pursuits; in helping others and addressing social problems, they are thought to be both generous and practical. Their hectic lives have accustomed them to structuring time, working from schedules and following rules. Along with this structured lifestyle is the expectation that, as students, they will be required to complete some form of standardized testing to demonstrate appropriate educational achievement. As a result, they are used to being assessed, receiving

focused feedback, and being goal-directed. Having participated in group-projects at school, they are team-oriented, socially networked, and able to organize and mobilize."[7]

The following are Howe's characteristics of the millennial generation born between the years 1981 and 2000.[7]

> *Special:* Have always been treated as special and important. This generation of children has been the most wanted. Every milestone was marked with celebrations and praise. They may carry a sense of entitlement about them and have an expectation of frequent positive feedback. It has been instilled in them that they are vital to the nation and to their parents' sense of purpose. They feel they are here to solve world problems that older generations have failed to solve. They may claim they want privacy, but they crave attention.
>
> *Sheltered:* Highly protected as children. They grew up in a time of increasing safety measures (car seats, baby on board signs, school lockdowns). They were rarely left unsupervised. They were sheltered from having to take care of their own conflicts as parents advocated on their behalf, and "spared" them from unpleasant experiences. As college students, they may expect faculty and staff to shelter, protect, and nurture them – and resolve their conflicts for them. Millennials are the focus of the most sweeping youth safety movement in American history.
>
> *Confident:* They are motivated, goal-oriented, and confident in themselves and the future. They expect college to help launch them to greatness. They may brag about their generation's power and potential. They have high levels of optimism and they feel connected to their parents. They are assertive and believe they are "right."
>
> *Team-Oriented:* They are group oriented rather than being individualists. They may sacrifice their own identity to be part of the team. They prefer egalitarian leadership, not hierarchies. They are forming a tight-knit generation. While they

are group-oriented within their own cohort, they may "politely" exclude other generations. They do not want to stand out among their peers; they want to be seen as part of the group. They dislike selfishness and are oriented toward service learning and volunteerism.

Achieving: Grade points are rising with this generation and crime is falling. The focus on getting good grades, hard work, and involvement in extracurricular activities, etc. is resulting in higher achievement levels. They see college as the key to a high paying job and success, and may miss the bigger picture of what a college education is all about. They are pressured to decide early on a career – and have been put on a career track orientation since grade school. Their focus is more on the world of achievement rather than personal development. The Boomer generation made their mark in the humanities and arts, whereas the Millennials prefer math and science fields.

Pressured: These children are tightly scheduled and used to having every hour of their day filled with structured activity. This generation may have lost a sense of pure spontaneous play. They may struggle with handling free time and time management in general. In elementary, middle, and high school, they have had more hours of homework and less free time than any of the previous generations. They feel pressured to succeed. They have been pushed hard to achieve, to avoid risks, and to take advantage of opportunities. They may take on too much, and then think others should be flexible with them when they want to negotiate scheduling conflicts. They think multi-tasking saves time and is a smart thing to do, but are not usually aware of the poorer quality of results.

Conventional: Respectful to the point of not questioning authority. They are civic-minded and believe the government knows what is best and will take care of them. They fear being considered non-conformist. Their clothing, music, and cultural markings will be very mainstream. They value their parents' opinions very highly. They support and believe in social rules, and are more in line with

their parents' values than most other generations have been. They are trying to invite rules and norms back into the culture.

This information reinforces the discussion of mathematics classes and millennial students held at the breakout session Professor Heublein attended at the International Council on Technology in Collegiate Mathematics.

Methodology

Procedure:

An aviation mathematics course will need to be developed. The areas of concentration of study will include arithmetic, algebra, geometry, and trigonometry. It must be stressed how to organize data to arrive at solutions to various practical application exercises. The newly designed exercises will be more practical in nature and thus enabling the students to enjoy a higher level of success and a working knowledge of mathematics necessary for their success.

Population:

The total number of students in the K-State at Salina Professional Pilot program averages 300 students.

Methods used:

Our method for meeting these outcomes is to involve faculty from both aviation and mathematics in a collaborative effort to develop materials, course pedagogy, and to build team teaching applications when possible.

Actively engaging the aviation students in the mathematics classroom through the modification of the material and exercises is the desire of the authors. The students level of desire to learn, understand, and appreciate the relevance of trigonometry and mathematics will be enhanced if the traditional trigonometry problems are modified. The following are examples of modified traditional engineering trigonometry exercises, which incorporate aviation terminology.

1. A pilot is flying in a direction of 43 degrees at a constant velocity of 240 miles-per-hour. Determine how far east and how far north from the starting point the pilot will have traveled after flying for 1 hour and 15 minutes.

2. The horizontal component of the distance traveled by a pilot is 23 miles and the vertical component of the distance traveled by the pilot is 3 miles. Determine to the nearest mile the distance the pilot has flown and the angle at which the pilot is flying with respect to the positive portion of the x-axis.

3. The airports at Hays, Liberal, and Salina form an oblique triangle (not a right triangle). A pilot is flying from Hays to Liberal, Liberal to Salina, and then from Salina to Hays. The distance from Hays to Liberal is 185 miles. The distance from Liberal to Salina is 284 miles. If the angle at Liberal is 38 degrees, determine the distance traveled on the flight from Salina back to Hays.

4. An aircraft departs an airport at a bearing of N30^{o}E. After flying for 30 minutes at a speed of 220 miles per hour, the pilot makes a 90 degree turn and heads to the northwest. After traveling for 15 minutes in this direction, determine the bearing, to the nearest 0.1 of a degree, the control tower should use to locate the aircraft.

5. An airplane leaves an airport in a direct line path at a speed of 225 mph. At a distance of 2 miles from takeoff, the aircraft must have a minimum altitude of 2000 feet. Determine the minimum angle of assent, to the nearest minute, the pilot must make.

6. An airplane takes off and flies at a fixed angle of 8^{o} to the horizontal. When the plane has reached an altitude of 500 feet, determine each of the following:

a) The horizontal ground distance, measured in feet, the plane has flown. Give the answer to the nearest 0.01 ft.

b) The actual distance, measured in feet, the plane has flown through the air. Give the answer to the nearest 0.01 ft.

7. An airplane travels a distance of 12,500 feet through the air at a uniform angle of climb and gaining 1450 feet in altitude. Determine each of the following:

a) The angle, measured to the nearest second, of climb of the aircraft.

b) The horizontal distance, measured to the nearest foot, the plane has flown through the air.

8. A rocket is fired at a velocity of 1800 feet/second at an angle of 65^{o} with the horizontal. Determine each of the following:

a) Determine the component of the vertical velocity to the nearest 0.01 ft/sec.

b) Determine the component of the horizontal velocity to the nearest 0.01 ft/sec.

Data:

The researchers administered to the aviation faculty a survey. (Attachment #1 and results) Only four of the eight professors teach courses that require the use of mathematics. Two professors report the mathematics skills of the students were four or below on a scale from one to ten, with ten being the highest score possible. Students had difficulty performing simple calculations of fractions without the use of a calculator. Students had difficulty manipulating simple algebraic formulas. The third faculty member rated the mathematics skills of his students at an eight but qualified the rating by stating not much mathematics is used in the course. All four respondents expressed a concern about a lack of student preparation for class and study skills.

Professor Heublein administered a different survey to the student pilot instructors. (Attachment #2 and results) The return was low with three of twelve returned. These instructors noted the students were lacking in arithmetic skills in division and decimals.

Professor Heublein administered a survey to his plane trigonometry class via KSU-Online in conjunction with his TEVAL of teaching performance. There was an increase in the students' study skills by taking the trigonometry course. There was a small increase in a favorable attitude of the study of mathematics. The results are in attachment #3.

Findings:

It is apparent that not enough information was gained from the surveys to be statistically valid. However, there was some quality information obtained about the study habits and desire to learn mathematics of the students. The surveys suggest the faculty believe the students must be engaged to create a learning atmosphere. Some faculty are concerned about the lack of study

skills of their students. The data collected from the student survey varied on the rating of their study skills. The students appreciate and become more enthused in studying trigonometry when the exercises are oriented to the use of aviation terminology. Some of the students see no reason to study trigonometry or any mathematics while other students enjoy and arise to the challenge of increasing their overall knowledge.

Summary, Conclusions and Recommendations:

By nature, students have a strong desire to be engaged in the classroom. The professor and the student must be on the same page in creating an active learning environment. Therefore, direct application of mathematics concepts and examples pertaining to the student's chosen major becomes extremely important. The course material must be presented in a format, which is enjoyable and relevant to the students. This will allow them to make easier connections between the material and the application of the material to their field.

From the small amount of data collected and analyzed, one should consider the development of an aviation mathematics course based upon the results of the aviation faculty survey and the authors' classroom experiences at K-State at Salina. The course would afford the aviation students another opportunity in becoming more efficient and proficient in their mathematics. The new course would actively engage the students and would ultimately help in raising their level of confidence in mathematics. The successful experience obtained from the development of early mathematics skills will also enable the students to become life-long learners.

Mathematics and science faculty recognize the need for and adoption of pedagogy methods that align with active student learning styles that engage all students and not limited to millennial students. Adopting mathematics exercises coupled to the students chosen major will increase their participation and interest. Consequently, there will be an increase in the learning and retention of these important building blocks of mathematical knowledge.

Further study on the implementation of an applied mathematics course and the introduction of application examples in subsequent mathematics courses needs conducted to include follow-up evaluation by the participating students. This preliminary study suggests active learning techniques and application examples can help engage students. This engagement should lead to

increased student learning as they gain confidence and skill sets needed in subsequent mathematics courses in their curriculum.

Bibliographic Information:

1. Felker, C. A. (1944). *Aviation mathematics*. Milwaukee, WI.: The Bruce publishing company.

2. Buchan, A.F., Borthwick, R., & Wadden, W.R. (2007). Aviation mathematics. Retrieved from http://openlibrary.org/b/OL10582532M/Aviation_Mathematics

3. Oblinger, D. (2003). Boomers, gen-xers and millennials understanding of the new students. *EDUCAUSE Review*, July/August, 37-47

4. McGlynn, A.P. (2008). Millennials in colleges: how do we motivate them. The Education Digest, 73(6), 19-22.
5. Elam, C., Stratton, T., & Gibson, D. (2007). Welcoming a new generation to college: the millennial students. Journal of College Admission, (195), 20-25.
6. Virginia Tech University. (2006). Student affairs administrator shares research on millennial generation. Retrieved from **http://www.studentprograms.vt.edu/publications/millennias.php**

7. Howe, N. & Strauss, W. (2003). Millennials go to college: Strategies for a new generation on campus: recruiting and admissions, campus life, and the classroom. Washington, D.C.: American Association of Collegiate Registrars and Admissions Officers.

8. Barnard, K., Collins, J., Oh, J., etal. (2003). Online Hybrid Courses Using University-Developed Software: Instructional Technology, Student and Faculty Perspectives Across Disciplines. 19th Annual Conference on Distance Learning and Teaching proceedings, August 2003, Madison, WI. And in 2004 with added data ASEE, SIDLIT, and Conference of College Composition and Communication CCCC proceedings.

9. Joyce, B., Weil, M., & Calhoun, E. (2004). Models of teaching. 7ed. Boston, MA.: Pearson education, inc.

Attachment #1

AVIATION FACULTY

SURVEY QUESTIONS AND RESULTS

1. How do you feel about the mathematics skills of your students?
    - The students do not know the basics. They cannot do simple problems with a calculator.
    - Math is not complicated in my courses. There is a small amount of algebra used to figure slopes and determine the equation of a line. High school mathematics should be enough to figure lift. Vectors are visual which is used in relative wind CFI ground school. I use no trigonometry in my class.
    - Skills are not very good but this is based on the mathematics (calculus through DEQ) I had in my undergraduate degree. They have difficulty with simple algebra exercises such as solving an equation for a variable. An example is solving the lift equation for a designated variable.
    - None of my courses requires the use of any math skills.

2. On a scale of 1 – 10, 10 being the best, rate the skill level of the students.
    - 8
    - 8 with some extremes.
    - 2 or 3
    - 4
3. What would you like to see the mathematics section do differently in our classes?
    - I have no complaints with what they are doing.
    - Use more application exercises.
    - Use knots/hr rather than mph.
    - If the mathematics problems were aviation oriented, the students may see more of the need to learn the mathematics process.
4. How do you feel about your student's preparation skills? (Do they study?)
    - No! They will not study until the finals and then they try to cram for the examination.
    - Pretty good bell curve (standard)
    - They prepare for some classes. Study nuts and bolts of aviation (background goes by even aviation)
    - There is a definite lack of a "desire to learn". Most have very poor study habits.
5. What is the student's attitude toward learning?
    - They want you to pour knowledge into their head with no effort on their part.
    - Bell curve. Good to high
    - They place the importance on getting through the course.
    - See #4

6. What are some mathematics problems that use some aviation statistics and terms that need to be incorporated into our classes?
    - Weight and balance.
7. Would you come over to my class and talk about mathematics you use in class. Go over some problem examples you use in your classes.
    - Yes
    - Balancing presentation. Want it to be useful to your class.
    - Yes, I would.

Attachment #2

STUDENT PILOT INSTRUCTORS

SURVEY QUESTIONS AND RESULTS

1. On a scale of 1 to 10, 10 being the best, please rate the mathematics skill level of your students. Please explain your rating.
    - 7—Most of them quickly do addition/subtraction
    - Most of the time, the students who get into aviation, like it so they tend to be fairly sharp. They do not really struggle too much with math. Math is very analytical and so is flying.
    - 7—Most of the students can complete most basic mathematics such as addition and subtraction but have difficulty with fractions and percentages.
2. Please list the areas or topics of mathematics content in which the mathematics department should emphasize more to improve and develop the mathematics skills of the students
    - I have not taken a mathematics classes at K-State at Salina.
    - Trigonometry definitely seems very useful in triangulating your position (with vectors)
    - Computing percentages and fractions in their head and not using paper and pencil.
3. Please list the areas or topics of mathematics content in which you feel the mathematics department could place less emphasis.
    - I have not taken a mathematics classes at K-State at Salina.
    - Division with decimals.
    - Complex equations, calculations, and theory.
4. On a scale from 1 to 10, 10 being the best, please rate how adequate do you believe the study skills of your students are? Please explain your rating.
    - 7---They study pretty well so they are not embarrassed by not knowing answers for progress checks.
    - This rating really depends upon the student. Some are great and study what you tell them and excel. Some do not and it shows.
    - Depends on the student. Some students' do a great job and study a lot so I rate them at a 9 but some students study terribly which I rate at a 3.
5. Please offer some mathematics problems that use some aviation statistics and terms that need to be incorporated into the mathematics classes to engage the aviation students in their course work.
    - We are flying on a heading of 080^{o} and we want to do a timed standard rate turn to 300^{o} (standard rate is 3^{o}/sec). This is a turn to the left of 140^{o}. This would take approximately 47 seconds to complete the turn.

Attachment #3

PROFESSOR HEUBLEIN'S PLANE TRIGONOMETRY CLASS

STUDENT SURVEY QUESTIONS AND RESULTS

Eighteen of nineteen students enrolled in MATH 150 Plane Trigonometry completed the TEVAL but only sixteen students answered the following questions.

1. Before taking this class, on a scale of 1 – 10, 10 being the best, please rate your skill level in mathematics.
    - Three rated their skills at 9.
    - Two rated their skills at 8.
    - One rated their skills at 7.
    - Four rated their skills at 6.
    - One rated their skills at 5.
    - Five rated their skills at 4.
2. After taking this class, on a scale of 1 – 10, 10 being the best, please rate your skill level in mathematics.
    - Three rated their skills at 9.
    - Three rated their skills at 8.
    - One rated their skills at 7.5.
    - Three rated their skills at 6.
    - One rated their skills at 5.5.
    - Four rated their skills at 5.
    - One rated their skills at 3.
3. On a scale from 1 – 10, 10 being the best, please rate how adequate you think your study skills are.
    - One student rated their skill at 8.
    - Five students rated their skill at 7.
    - Five students rated their skill at 6.
    - One student rated their skill at 5.
    - Two students rated their skill at 4.
    - One student rated their skill at 3.
    - One student rated their skill at -12.
    -

    For questions, four and five please give a short narrative explaining your response.

4. Before taking this course, please describe your attitude toward learning mathematics?
    - I liked math when it was just algebra.
    - Mathematics is my favorite subject. I tend to be a quick study when it comes to math.
    - Enthusiastic!
    - There is a lot of math that can be applied to life, and there is an equal or greater amount of math that has no practical use in everyday life. I choose to learn it not because it is practical or not, but because it is enjoyable. I like that all the

answers are definite, whereas in areas like English, answers can be interpreted differently.

- I have always loved math before trig. I was the one in math class that helped others. I am the one that is needing help now.
- I like to learn especially math.
- Not very interested.
- I am not the biggest fan of math, but can see why some things are important.
- Mathematics has never been easy for me but it really helps when you have a teacher such as Mr. Heublein to help you along.
- I've always been interested in mathematics. Nothing has changed.
- I just wanted to get it over with. I'm not very good at math and don't like to do it.
- Don't like trig.
- I was excited to be taking another math class after having such a great college algebra class and instructor!
- I am not a fan of math, but I am not terrible at it so I do actually want to learn this stuff to prepare me for calc.
- I have never been too fond of anything that was higher levels of mathematics. I have always tried hard but come up short every time. I have a great understanding of basic math, and statistics, but everything else has always been a struggle.

5. Now that you have almost completed taking this course, please describe your attitude toward learning mathematics?
    - When will I use this crap when I'm flying a plane ?????
    - The same, nothing has changed.
    - Extremely discouraged.
    - Same as before I took the class.
    - I'm not a big fan of math anymore.
    - I still like to learn.
    - Don't mind doing homework anymore and feel better about my math learning abilities.
    - Still not the biggest fan of math, but feel I'm getting the hang of it a little better.
    - I have a better understanding of trigonometry.
    - Nothing has changed.
    - It is about the same. I would rather just get it over with.
    - Hate trig.
    - I'm really feeling down about my math skills and I hope that the next math I take my instructor can see I am trying and can teach in a manner I can learn. And if for some reason I don't understand I can feel comfortable asking more questions and he/she can teach it in another way of understanding the same concept.
    - I have the same attitude towards math.
    - I would still say that I feel the same way. I understand that I haven't been exposed to as much math as some of my fellow classmates and that could be why I can try and seem to get nowhere, but in all reality I have made some positive jumps along the way.