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Certification Pass Rates of Students Following Multiple Years of Drafting Courses

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CERTIFICATION PASS RATES OF STUDENTS FOLLOWING MULTIPLE YEARS OF DRAFTING COURSES

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Approval Page

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CHAPTER I

INTRODUCTION

Most communication has been done through drawing early on as different peoples did not speak the same languages. Current students that wish to continue to communicate through technical drawings aspire to do so through the practice of drafting. High school drafting courses offer many skills but the search for full efficiency has led to the use of computer aided drafting, thus leaving many basic hand drafting skills less often practiced, and an art is struggling not to get lost. The process of technical drawings is usually involved with drawing instruments, but can also be performed as freehand sketching. If an engineer or architect were to need to produce a hand drafted mechanical drawing, it would require precision instruments to ensure accuracy and geometric equivalence. It is now possible for students to grasp these concepts through computer aided drafting, CAD, and use it as their tool to produce accurate technical drawings.

The software companies that produce 2D and 3D CAD software engines are numerous, but some are using industry standards to keep an edge in the field. Since tiny numbers can be significant in science and engineering, the software user must be concerned with accuracy both in the way instruments obtain data and the way a computer calculates it (Henderson, 1999). If an individual gets trained on a particular CAD

software, then they can become certified in that specific software, thus having 'proof' that they possess knowledge at a certain level on that software. The issue that has been argued by many educational committees is whether this means they know the core drafting skills? This study seeks to find if multiple drafting courses give a high school student a better chance of passing one of these certification exams through more exposure to drafting, engineering, and architectural concepts and standards.

STATEMENT OF THE PROBLEM

The problem of this study was to determine if the number of high school drafting courses taken increases the pass rate on the Brainbench AutoCAD certification exam.

HYPOTHESIS

To guide this study the following hypothesis was established.

H_1: Students who take two or three CAD courses have an improved chance of passing the Brainbench AutoCAD certification test due to longer exposure to the software, drafting standards, and content.

BACKGROUND AND SIGNIFICANCE

Engineering and architectural businesses have always been lucrative, and many desire to become a part of one of these careers. Students that are successful at mathematics are usually trained in the sketching and drafting arts from an early to mid teenage years. The concepts for putting together technical and mechanical drawings can be taught by traditional hand drafting as well as in a CAD laboratory setting. Some teachers in this area are career switchers, that is, they come from other backgrounds that might give them real life experiences in drafting that they can share with the students. Others might not be effective teachers if they were not certified or trained such as a photographer or electrician.

Students can learn the geometric and industry standards of engineering and architectural principles in the public high school drafting lab setting. The basic sequences of drafting courses are: Basic Technical Drawing, Engineering Drawing, and Architectural Drawing. Basic Technical Drawing is a required prerequisite for either of the other two classes, but both Architectural and Engineering Drawing are not required of each other. The certification is earned at the end of each of these courses by students who have a “C” average for the year and passes the certification test. If he or she passes, Virginia Beach students may omit

the final exam, so there is a very evident motivational factor for the learners. The technical software course is developed with the end user in mind, separated into subsystem units (Chen, 2005).

Just as in core classes at the high school level (History, English, Sciences, and Mathematics), many teachers find themselves making tough choices as far as content for their daily lesson plans. There is great pressure to have high pass rates for the graduation required Standards of Learning tests and the same follows through for teachers who give certification exams. This leads to instructors teaching to the test, rather than focusing on what they know best, which is a proven way to keep students interested in a subject. The teaching landscape has changed because of technology and communication advances (Geith, 2009). When examining drafting instructors, one must observe the teacher that still values drafting and geometric skills versus a teacher that just teaches enough of the software for the students to pass the class or just get certified. This is significant through students being software certified at the appropriate class level to ensure true competency in accordance with the Virginia competency lists for core drafting skills.

LIMITATIONS

The following limitations were recognized as having an effect on the outcome of this research.

1. The study was limited to student data gathered from 2007 through 2009 drafting courses at Landstown High School and Technology Academy in Virginia Beach, Virginia.
2. The study was limited by the use of the Brainbench 2004 AutoCAD certification test given through BrainBench.com.
3. The Brainbench 2004 AutoCAD certification exam covers 40 varying types of questions, all multiple choice, but some with files that must be downloaded, manipulated in the software, then the correct answer chosen from the list of five different answers. These 40 questions are chosen randomly from a set of 160 possible questions in the server bank. This should give a student who has taken all three classes a better chance of understanding any of these possible 160 questions.

ASUMPTIONS

In this research study there were several factors which were assumed to be true and correct. These assumptions were:

1. The Brainbench 2004 AutoCAD certification examination is the best fit certification for the drafting courses taught at Landstown High School and Technology Academy.
2. The students who took the certification test have had multiple review exposure in class to get the highest possible score.
3. A small percentage of students had internships outside of school and experience in other CAD engine softwares.
4. Students that take the certification exam the first time will be the study group, as some of them will also retake the certification a second time before they graduate high school.
5. The certification consists of 40 varying types of questions ranging from all aspects of the three possible drafting courses.

PROCEDURES

This study will be conducted by cross referencing the data of students that have taken one, two, or three of the drafting courses available at Landstown High School and Technology Academy. The students may take the certification each year they take a drafting course as long as they keep a minimum "C" average throughout the year. The data has been collected on site for the last seven years, but the research will be concentrating on the last four years of the Brainbench AutoCAD

national certification exam. The data will be divided into passing scores from 2.75 to 5.00 from each of the three possible drafting courses. Official Virginia competency standards for these drafting courses will be analyzed and compared to the pass rates for the AutoCAD certification tests.

Definition of Terms

For clarification, the following terms should be understood:

2D/3D – An abbreviation for two dimensional/three dimensional representations.

AutoCAD – This is the software that the certification exam is centered on, connecting as a main research component. It provides a user 2D and 3D drafting engine for modeling and technical drawing.

Brainbench – The website http://www.brainbench.com/ is an aptitude testing server site with a various array of employee success certification tests. It offers a 40 question certification test from a population of 160 possible questions in drafting.

CAD (CADD) – An abbreviation for Computer Aided Drafting and/or Design. A software tool used for efficient drafting and design project creations that can include 2D and 3D schematic representations.

Certification – A test that is proof that a person has passed the minimal standards of a software or skill.

OVERVIEW OF CHAPTERS

Chapter I presented an overview of this research study. AutoCAD certification pass rates are the focus of the student pass rates according to the number of high school drafting courses each has taken at the time. The researcher used the last four years as a basis of the data collection and has first-hand knowledge of the classes, curriculum, and certification processes. The limitations and assumptions were stated and the special terms defined. The data will be split up into pass and fail categories. The Virginia competencies will also be examined and compared in Chapter II to help define what is considered a standard for each of the three courses. Chapter III will define the methods and procedures for the population and data collection limits. Chapter IV will provide the findings of the data collected by this researcher and Chapter V will provide a summary, conclusions, and recommendations to better the learning environments of high school drafting students.

CHAPTER II

Review of Literature

The research done for this study is supported by a various array of skill and competency standards. Since the study focuses on the pass rates of a certification test due to more courses taken, some of the reviewed literature is focused on the skills gained at these different levels of education. The certification examinations are a point of proof that shows that a student understands the use of specific software, but does this correlate to the student understanding the core concepts of drafting skills? Some authors in the field think the problem is deeper, being that too much attention is put toward teaching information our students will rarely use and not nearly enough focus on essential skills they will apply on a daily basis (Mueller, 2009). This chapter will discuss the relationships between the Virginia competencies taught in the three high school drafting courses and how they relate to the AutoCAD certification examination.

STUDENT LEARNING NEEDS

What do students need to succeed at the AutoCAD certification examination? The Virginia Department of Education has published a list of competency standards for each course that should be taught during the school year. The course variables for Basic Technical Drawing,

Engineering Drawing and Design, and Architectural Drawing are that each school has different supplies and software, so the method of teaching these competencies varies from school to school. So then the focus could be on the critical skills necessary for passing the certification examination. This certification gives an industry standard that can be applied to resumes for jobs during high school and after graduation. Students need to see the connection between curriculum and real life, and the reasons to understand how to solve problems, communicate clearly, and collaborating successfully with others (Mueller, 2009). This acquired skill can also lead to a student's ability to monitor his or her own progress and make adjustments when needed (Mueller, 2009).

TECHNICAL DRAWING AND DESIGN

The competencies for the three drafting courses are the key points that must be analyzed to connect the certification questions. The pass rate for this certification examination in Virginia was 59.98% with 541 of 902 test takers passing in 2009 (VDOE, 2010). The first set of competencies this study will focus on will be the 29 competencies for Basic Technical Drawing (course VA TE 8435), presented as the file that each student has on record for the course taken (VDOE, 2010). Please refer to Appendix B for Virginia competencies for 1st Year Drafting (Technical Drawing and Design). The course goes through core drafting

and design techniques and standards throughout the year, from drawing setup to dimensioning.

Only a few of these competencies apply to the certification for the software used by most of Virginia high school teachers, AutoCAD from AutoDesk. A connection can be made for competencies 11, 21, 22, 24, 25, and 28. In competency 11, technical drawing and design standards are discussed and applied by the class. Competencies 21 and 22 apply the mathematical principles and geometric applications, which are usually taught through software and board drafting (T-square and triangles) use. Competency 24 deals with the use of various measurement systems used in the world, which has a direct percentage of the certification examination (Brainbench, 2004). Competency 25 is an even bigger part of the certification examination, focusing on the dimensioning and annotation of technical drawings. Competency 28 makes the computer aided drawing software a required part of the Virginia competency for this first year drafting course (VDOE, 2010). There is room on most Virginia technical education course competency student sign off sheets for the flexibility of local competencies to be applied as availability of equipment and resources varies from district to district.

2nd YEAR DRAFTING COURSES INVESTIGATED

The first year course leaves a number of items that are taught during the year long course but do not apply to the certification that has become a standard among high schools across the commonwealth of Virginia. This is where the second year courses bring connections. Two experts in the field have weighed in on the validity of the list toward the certifications. "I have taught engineering concepts, drafting courses, and material processes/construction classes for the past 18 years across Virginia high schools" (Nestor, 2010). He exclaims, "A student cannot be forced to learn the necessary drafting standards *and* full software aspects in just one year. "It's just too much for a young learner to retain" (Dyer, 2009). As a technology teacher of 19 years, Mr. Dyer continued on that thought by saying, "Students have a greater grasp of the software by their second and third year of drafting courses, but does that make them better drafters from a hands-on geometric and standards point of view? I think, unfortunately, not."

This does not mean that the other competencies not related to software certification should be abandoned, but that perhaps the certifications should be given only at the second and third year of a student's drafting course career, making them more authentic to what is taught. The authentic assessment can be defined into five categories: Questions to Ask, Standards, Authentic Tasks, Criteria, then Rubric

Construction (Mueller, 2009). Connecting existing standards with those of a quality professional certification examination can be a key feature to fill each of those five categories.

ENGINEERING DRAWING AND DESIGN

The standards for Engineering Drawing and Design can help define if students are becoming, from a drafting point of view, reflective mathematical learners and standard-literate users and drafters. Please refer to Appendix C for the Virginia competencies for the 2nd Year drafting course, Engineering Drawing and Design. The year long course offers more exploration into the software and its uses in 2D and 3D drafting and design concerning machines and engineering principles

Competencies number 12, 13, 14, and 16 are applicable to the AutoCAD certification examination but it is the extra amount of time the student is exposed to the software while doing the projects that help enhance their understanding of the software (Nestor, 2010). Competencies 12 and 13 reinforce what was learned in the first year drafting course. Competencies 14 and 16 are applicable to the certification examination as there are about 20% of the questions that have working drawing files (.dwg) that must be saved to the C drive (desktop), opened in AutoCAD, examined and manipulated, and then an answer is chosen from the five possible choices. These drawing files are

sometimes simple object and command manipulations, but also include working technical drawings (Brainbench, 2010). These are an important part of the certification examination process, but understanding the sequence of sentences, phrases, and individual words in text questions will bring many responses to mind. It is deeply important for the certification taker to focus on the answer choices by selecting exactly the meaning of each phrase (Gelernter, 1994). This is a skill that is also affirmed through extended time exposure to more software usage.

Some of the tested concepts are taught through advanced individual and team projects in Engineering and Architectural Drawing courses. These projects are often complex and focused on what the teacher is trained in or centered on the instructor's real world experiences. These learner projects have a magic, thrusting forward successes through the failures of earlier simpler exercises and drawings (Gelernter, 1994).

ARCHITECTURAL DRAWING AND DESIGN

The Virginia technology course, Architectural Drawing and Design (VA TE 8437), provides some more exposure to the AutoCAD software, mostly through the teaching of history and standards in building and community construction. The 2D drafted house plan is only the beginning of the concepts taught in this course. Skilled architectural

CAD technicians are expected to know how to correct and modify site plans. The 3D view and walk-through of a house is now part of the learning and necessary skill processes for architects (Henderson, 1999). Please refer to Appendix D for the Virginia competencies for the 3rd Year drafting course, Architectural Drawing and Design.

This architectural course gives much more depth to the standards of drafting, and some of the advanced commands are utilized while connecting parts of the student made site plan. The certification examination has a number of questions (approximately 12%) that deal with managing files and creating tables from data saved in database files (Brainbench, 2010). Competencies 10, 11, and 21 deal directly with these software certification areas. The histories of sectional views for buildings, most specifically wall sections, help students understand the inner subsystems of a larger, more complex system.

BRAINBENCH AUTOCAD CERTIFICATION SKILL LIST

A skill list is available from Brainbench.com for the AutoCAD certification examination. It is these skills that are needed to pass the certification examination which is gained through extended exposure to the software (Brainbench, 2010). It is important to know that this certification examination is for adult professionals, so high school students are ahead of the curve when using and becoming certified in

this software. Refer to Appendix E to view the content found on the Brainbench AutoCAD certification examination.

SUMMARY

Given what competencies are required for passing in the three mentioned courses in this study, the certification examination must be scrutinized as to see if it fits the validity of what is taught. There is limited research on these specific AutoCAD certification pass rates, but the core skills that are represented by the areas tested are still important and needed. The CAD software makes a user more efficient than a hand drafter, but more research dealing with the time exposed to the software and other Virginia competencies may be helpful in passing the certification examination. This study hopes to provide research that can be used in the future to help fill the void on this specific software certification pass rate data.

CHAPTER III

Methods and Procedures

This research study seeks to determine whether or not taking multiple drafting courses at Landstown High School correlates with students' AutoCAD certification examination pass rates. An explanation of the population studied, research variables, classroom procedures, instrumentation, data collection, statistical analysis, and a summary are included.

POPULATION

The population for this study was from the Landstown High School technology department in the years between 2007-2009. Subjects in this study were the 329 high school students that took a drafting course which made them eligible to take the certification exam in May of that year. All of the students from all drafting classes that took the certification examination were included in the sample for this study.

RESEARCH VARIABLES

The variables for this study were if high school students had taken one, two, or three drafting courses before they took the certification examination for the AutoCAD software on Brainbench.com. The students were also required to hold a 'C' average for the year. The more drafting

classes taken can expose the students to more of the software being certified.

CLASSROOM PROCEDURES

All of the drafting students follow a full curriculum that infuses the AutoCAD software with drafting content and principles. The teaching instruments are the software manual Applying AutoCAD by T. Wohlers (1985-2010), diverse worksheets, and instructor real world examples and experiences.

INSTRUMENT USED

The procedure that was used to collect the data includes the certification scores from the drafting students. The examination is a 40 question test with five possible choices for the correct answer (See Appendix A). Some of the questions have a file that must be downloaded to the computer hard drive, opened in AutoCAD and examined and manipulated as per the directions of the question. Then the learner must choose an answer from the five possible choices, all within three minutes. If a student does not make a choice within three minutes the examination automatically goes to the next question and that missed question is counted wrong. The online examination is adaptative in that if the learner gets 4 or 5 wrong from a particular subject area it does not ask any more questions from that area. The examination instead poses

questions from new areas in hopes of finding a strong point in the learner's AutoCAD experience. This helps test takers become certified if they are used to a certain area of software use (Architecture versus engineering versus naval design, etc.). The scores and pass rates were collected at the end of each school year.

METHODS of DATA COLLECTION

The data were collected from certification examination scores which were taken at Landstown High School between 2007 and 2009 by drafting students. Each question has the same weight in the score ranging from 0.00 – 5.00 with a 2.75 being a passing score. Students can take this certification after each of the three years of different drafting courses.

STATISTICAL ANALYSIS

The finished certification examinations were automatically scored from the website Brainbench.com at the conclusion of each student's examination. The data were recorded in tables and using chi-squares with the pass/fail information and number of drafting courses taken.

SUMMARY

This chapter presented the methods and procedures that this researcher used in this study. Chapter III included the population

studied, research variables, classroom procedures, instrumentation, data collection, and the methods used to analyze the data which will be presented in Chapter IV and thus, testing the hypothesis. This builds on the limits and assumptions given in earlier chapters as well as the learner's needs and the certification subject content.

CHAPTER IV

FINDINGS

The purpose of this study was to determine if the number of high school drafting courses taken increases the pass rate on the Brainbench AutoCAD certification examination. This chapter presents the statistical analysis of data collected for this study.

DATA REPORTING

The findings are based from the data collected from 329 students in the technology department at Landstown High School. The AutoCAD certification scores were gathered from the BrainBench.com. A comparison of student certification pass rates with the transcripts of the students' drafting courses taken prior to the exam will make the correlation for the data.

DATA ANALYSIS

The relationship between number of high school drafting courses taken and the certification pass rate of students was computed using the Chi-square analysis ($\times^2$). The data were divided into two squares to get each set of $\times^2$ values. There were a total of 329 students during the two years of testing for this research. With only a 17% pass rate for having one course taken prior to the certification, the second and third year

raises the pass rate to almost 50%. Tables 1, 2, and 3 have the total data for these two years. The following tables reflect the statistics gathered for this research on the hypothesis: H_1: Students who take two or three CAD courses have an improved chance of passing the Brainbench AutoCAD certification test due to longer exposure to the software, drafting standards, and content.

Table 1

2007-2008 Drafting Students

	Course 1	Course 2	Course 3
Pass	14	9	15
Not Pass	77	27	23

Table 2

2008-2009 Drafting Students

	Course 1	Course 2	Course 3
Pass	12	11	12
Not Pass	78	25	26

Table 3

Combined Data for Both Years

	Course 1	Course 2	Course 3
Pass	26	20	27
Not Pass	155	52	49

These data were combined by years and then further divided into two squares: 1 vs. 2 and 1 vs. 3 drafting courses taken prior to the certification examination. A chi-square score of 6.23 was found for the course one versus course two comparisons, as seen in Table 4. A chi-square score of 14.64 was found for the course one versus course three comparisons, as seen in Table 5.

Table 4

1 versus 2 Drafting Courses Taken Prior to Certification

	Course 1	Course 2
Pass	26	20
Not Pass	155	52

$\times^2 = 6.23$

Table 5

1 versus 3 Drafting Courses Taken Prior to Certification

	Course 1	Course 3
Pass	26	27
Not Pass	155	49

$\times^2 = 14.643$

Note: þ>.05=3.84 and þ>.01=6.64 were used for all data comparison.

SUMMARY

In Chapter IV, the researcher presented and explained the data received from the two years of high school BrainBench.com AutoCAD certification pass rates of drafting students. From this data the researcher can see tables that show a difference in the pass rate of students that have taken more than one class. Chapter V will summarize the research, analyze the results, draw conclusions from the data and make recommendations.

CHAPTER V

Summary, Conclusions and Recommendations

The purpose of this chapter is to bring together what has been derived from the research data collected. Conclusions then follow to answer the hypothesis that was brought forth in this study and recommendations are suggested based upon the information analyzed in the study.

SUMMARY

The problem of this study was to determine the relationship between certification examination pass rates and the number of drafting courses taken prior to the certification. The hypothesis of this study was:

H_1: Students who take two or three CAD courses have an improved chance of passing the Brainbench AutoCAD certification test due to longer exposure to the software, drafting standards, and content.

The certification test questions spanned a number of subjects from AutoCAD content to drawing setup, to plotting, to correct dimensioning. All students enrolled in the one, two, or three drafting courses took the certification examination at the end of the year, and there were students who took one, two, and three drafting courses, based on the amount of drafting courses they completed. The limitations for this study were:

1. The study was limited to student data gathered from 2007 through 2009 drafting courses at Landstown High School and Technology Academy in Virginia Beach, Virginia.
2. The study was limited by the use of the Brainbench 2004 AutoCAD certification test given through BrainBench.com.
3. The Brainbench 2004 AutoCAD certification exam covers 40 varying types of questions, all multiple choice, but some with files that must be downloaded, manipulated in the software, then the correct answer chosen from the list of five different answers. These 40 questions were chosen randomly from a set of 160 possible questions in the server bank. This should give a student who has taken all three classes a better chance of understanding any of these possible 160 questions.

The chi-square (x^2) statistical analysis was then calculated from the two years of data for pass rates comparing testing results for enrollment in one, two, or three drafting courses.

CONCLUSION

This study set out to determine the relationship between pass rates and the number of drafting courses that a student has taken to give them more exposure to the software and drafting techniques and standards. The following hypothesis was answered:

H_1: Students who take two or three CAD courses have an improved chance of passing the Brainbench AutoCAD certification test due to longer exposure to the software, drafting standards, and content.

The chi-square (x^2) value of 6.23 was found to be the difference between students who completed one year of drafting versus two years of drafting ($p \geq .05 = 3.84$). A chi-square (x^2) value of 14.62 was found to be the difference between students who completed one year of drafting versus three years of drafting ($p \geq .01 = 6.64$). Therefore the researcher accepts the hypothesis that students who take multiple drafting courses have a higher certification pass rate and can conclude that students should take the certification test during the second and/or third year of drafting to be more successful at passing the examination and earning a certificate.

RECOMMENDATIONS

Based upon the findings and the conclusions of this study, the researcher includes the following recommendations:

1) Certification tests should be given to only second and/or third year drafting students to help conserve money within the school system by testing students with a higher chance of passing the certification.

2) Similar research should be conducted in a similar format with a larger population (whole Commonwealth of Virginia).

3) AutoCAD should continue to work with state departments of education so that the certification examinations are designed to test drafting principles instead of just software techniques.

4) Teachers involved in drafting certifications can continue to provide data on pass rates to each other to find the best practices in drafting course competency correlation.

5) A better certification test should be sought that aligns with the course competencies for drafting as outlined by the Virginia Department of Education.

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APPENDIXES

Appendix A: Example Certification Question

Brainbench

AutoCAD **2 Min. 50 Sec. Remaining**

Problem: Open the AutoCAD drawing: *Click Here*

Change the white liens shown into a single, splined, closed polyline that is 0.3125 units wide.

Question: Referring to the open drawing and instructions, what is the length of the polyline you created, and is any part of the green arc visible?

Choice 1: ○ 63.8873, no

Choice 2: ○ 63.8873, yes

Choice 3: ○ 59.7525, no

Choice 4: ○ 59.7525, yes

Choice 5: ○ 59.6525, yes

Record Answer AutoCAD 2004 (U.S.) (Interactive) Question 26 of 40

○ **Take a 15 minute break AFTER this question**

Appendix B: Technical Drawing and Design

8435 (co-op not available) 36 weeks	Technical Drawing and Design TASKS/COMPETENCIES		Date	Rating
	Implementing Virginia's CTE Course Requirements			
Required	001	Demonstrate Virginia's Workplace Readiness Skills in course activities.		
Required	002	Apply Virginia's All Aspects of Industry elements in course activities.		
Required	003	Identify Internet safety issues and procedures for complying with acceptable use standards.		
	Participating in the Student Organization			
Required	004	Identify the purposes and goals of the student organization.		
Required	005	Explain the benefits and responsibilities of membership in the student organization as a student and in professional/civic organizations as an adult.		
Required	006	Demonstrate leadership skills through participation in student organization activities, such as meetings, programs, and projects.		
	Technical Drawing and Design			
Required	007	Define "technical drawing."		
Required	008	Define "design."		
Required	009	Describe the design process.		
Required	010	Describe the history of drawing and design.		
Required	011	Apply and use technical drawing and design standards.		
Required	012	Use and maintain a reference library of files and technical data.		
Required	013	Research, design, and develop patterns (i.e., packages, casting, and sheet metal).		
Required	014	Prepare technical sketches, using orthographic projections.		

Required	015	Prepare pictorial technical sketches.		
Required	016	Letter freehand (i.e., notes, annotation, measurement).		
Required	017	Correct and revise drawings.		
Required	018	Use and maintain drawing equipment.		
Required	019	Select appropriate drawing-related media and materials.		
Required	020	Prepare auxiliary view drawings.		
Required	021	Apply basic geometric construction principles.		
Required	022	Apply mathematical calculations involving practical geometry.		
Required	023	Prepare multiview drawings.		
Required	024	Use English and metric measuring devices and systems.		
Required	025	Apply basic principles of dimensioning and annotations.		
Required	026	Prepare sectional view drawings, using conventional principles.		
Required	027	Prepare pictorial drawings (i.e., isometric and oblique).		
Required	028	Gain fundamental computer-aided drawing/design (CAD) ability in drawing and dimensioning an object.		
Required	029	Describe career qualifications, responsibilities, and wages using various resources and the Internet.		

	Locally Developed Tasks/Competencies

Appendix C: Engineering Drawing and Design

8436 (co-op not available) 36 weeks	Engineering Drawing and Design TASKS/COMPETENCIES		Date	Rating
	Implementing Virginia's CTE Course Requirements			
Required	001	Demonstrate Virginia's Workplace Readiness Skills in course activities.		
Required	002	Apply Virginia's All Aspects of Industry elements in course activities.		
Required	003	Identify Internet safety issues and procedures for complying with acceptable use standards.		
	Participating in the Student Organization			
Required	004	Identify the purposes and goals of the student organization.		
Required	005	Explain the benefits and responsibilities of membership in the student organization as a student and in professional/civic organizations as an adult.		
Required	006	Demonstrate leadership skills through participation in student organization activities, such as meetings, programs, and projects.		
	Engineering Drawing and Design			
Required	007	Define "engineering drawing."		
Required	008	Apply the engineering design process.		
Required	009	Investigate engineering-related careers, using various resources and the Internet.		
Required	010	Acquire specification information, using the Internet and/or manuals.		
Required	011	Use and maintain a reference library of files and technical data.		
Required	012	Apply advanced principles of dimensioning and annotation.		
Required	013	Use English and metric measuring devices and systems.		
Required	014	Create thread representations.		

Required	015	Prepare freehand technical sketches.		
Required	016	Design an assembly and prepare working drawings.		
Required	017	Use descriptive geometry to solve problems.		
Required	018	Create, visualize, and analyze an object, using solid modeling.		
Required	019	Create development drawings.		
Required	020	Create an example of mechanical, electrical, thermal, and/or fluid drawings.		

	Locally Developed Tasks/Competencies

Appendix D: Architectural Drawing and Design

8437 (co-op not available) 36 weeks		Architectural Drawing and Design TASKS/COMPETENCIES	Date	Rating
	Implementing Virginia's CTE Course Requirements			
Required	001	Demonstrate Virginia's Workplace Readiness Skills in course activities.		
Required	002	Apply Virginia's All Aspects of Industry elements in course activities.		
Required	003	Identify Internet safety issues and procedures for complying with acceptable use standards.		
	Participating in the Student Organization			
Required	004	Identify the purposes and goals of the student organization.		
Required	005	Explain the benefits and responsibilities of membership in the student organization as a student and in professional/civic organizations as an adult.		
Required	006	Demonstrate leadership skills through participation in student organization activities, such as meetings, programs, and projects.		
	Architectural Drawing and Design			
Required	007	Define "architectural drawing."		
Required	008	Analyze architectural styles.		
Required	009	Describe the fundamentals of the architectural design process.		
Required	010	Develop a site analysis.		
Required	011	Use and maintain a reference library of files and technical data.		
Required	012	List and describe factors and methods of financing.		
Required	013	Prepare design sketches.		
Required	014	Design a floor plan.		
Required	015	Design a foundation plan.		

Required	016	Create sectional views.		
Required	017	Design exterior perspective views.		
Required	018	Render presentation designs.		
Required	019	Design exterior elevations.		
Required	020	Design interior elevations.		
Required	021	Create door and window schedules.		
Required	022	Acquire specification information, using the Internet and/or manuals.		
Required	023	Develop and design electrical plan requirements.		
Required	024	Build presentation models.		
Required	025	Create a mass model of a building design.		
Required	026	Gain fundamental computer-aided drawing/design (CAD) ability in applying standards for building design.		
Required	027	Create and use architectural libraries for insertion into a building design.		
Required	028	Create a walk-thru presentation of a section of a building.		
Required	029	Describe career qualifications, responsibilities, and wages, using various resources and the Internet.		

	Locally Developed Tasks/Competencies

Appendix E: AutoCAD Certification Outline

Test Outline

Advanced Entities

- Advanced Entities and Shapes
- Associative Dimensions
- Attributed Blocks
- Hatching Options
- Text Options and Editing

Annotation

- Dimensioning Options and Editing
- Hatching Options
- Text Options and Editing

Drawing

- Basic Entities
- UCS Usage
- Units - English vs Metric
- Using Coordinate Systems
- Using Osnaps

Editing

- 2D Manipulation
- 3D Manipulation
- Copying and Stretching
- Selecting and Grips

File Management

- Blocks
- Plotting
- Save and Open
- Support Structure Configuration
- Undo and Redo

Format

- Attribute and Text Usage
- Color and Linetype
- Layers
- Properties Management
- Standards Management

User Preferences

- Color versus Style-based Plotting
- Interface Configuration
- Menu Customization
- Non-critical Variable Settings

Utilities and Programming

- Extracting Drawing Data
- Importing and Exporting Data
- LISP, DCL, VB
- Scripting
- Stoing and Using Entity Data
- Storing and Using Entity Data

Viewing

- Shading, Hiding, Rendering
- Viewpoint Manipulation
- Viewports