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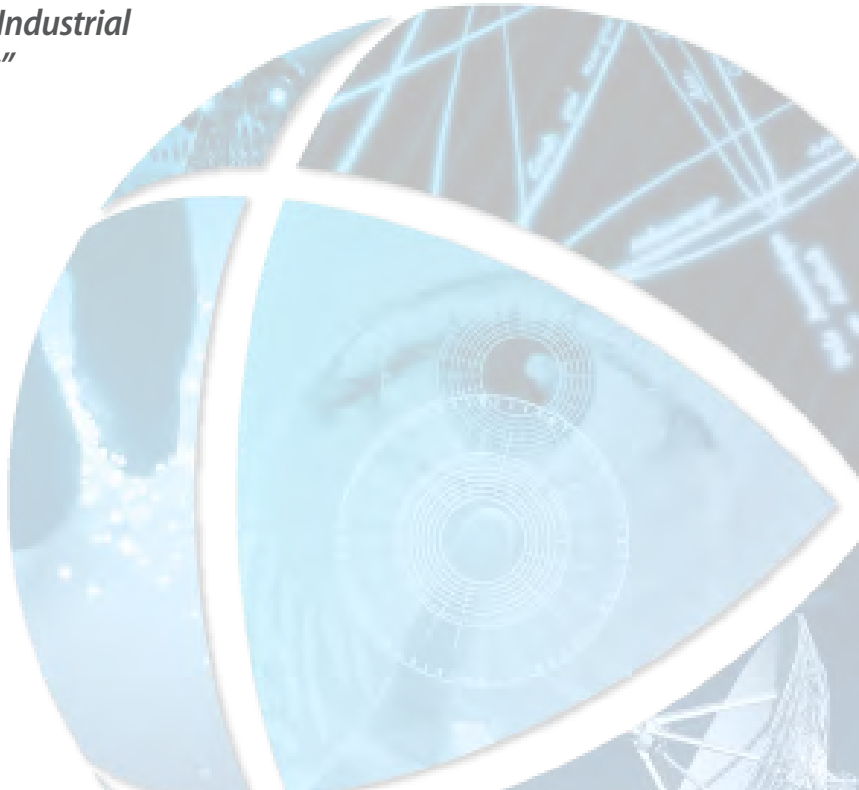

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Measuring Educational Program Effectiveness Using the Associate Constructor Exam

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ABSTRACT

External sources of validation for undergraduate construction management educational programs may include accreditation by the American Council for Construction Education and testing of students through the American Institute of Constructors, Associate Constructor exam program. This paper includes an analysis of educational program effectiveness by measuring student performance on the Associate Constructor exam by students in an American Council for Construction Education accredited construction management program at a regional comprehensive university. Exam scores were observed for a three-year period and analyzed to identify variables that might significantly affect student performance on the Associate Constructor exam. Students' combined math and verbal Scholastic Aptitude Test scores of 1002 out of 1600 were found to be a statistically correlated to their Associate Constructor average exam scores of 185 out of 300. The analysis indicated that an alternate means to measure program effectiveness should be investigated or that faculty should develop an applicable curriculum that prepares students for the Associate Constructor exam. Similar results may be found with students' performance in other technology or engineering technology programs accredited by the Accreditation Board for Engineering and Technology.

INTRODUCTION

In 1994, the American Institute of Constructors, Constructor Certification Commission was formed to administer the preparatory Associate Constructor (AC) exam and the Certified Professional Constructor (CPC) exam to certify construction managers. The AC is used by many institutions to assess their programs (Bruce, Sauer, and McCandless, 2008). The Commission began testing in 1996 (Fernntella, 2002). The benefits to the construction industry, employers and construction professionals of certification are driving the growth and popularity of the CPC and AC exams (Bruce, et al. 2008). The objectives of professional certification are "to promote competency in the construction profession by:

1. Providing an internationally recognized certification of constructor skills and knowledge, thereby assisting the public, client, and employer in the recognition of the construction industry;
2. Providing an independent assessment of an individual's skills and knowledge through the examination process;
3. Establishing and assessing the level of education and experience required for certification; and
4. Providing a systematic plan of Continuing Professional Development for career advancement" (American Institute of Constructors, 2009, pg 3).

This article includes an analysis of students' performance on the Associate Constructor exam by Construction Management (CM) students at Western Carolina University as a part of the on-going program evaluation process. Seniors in the CM major at Western Carolina University are required to sit for the American Institute of Constructors (AIC), Associate Constructor's (AC) exam during their last semester prior to graduation with the intent of assessing the level of practical construction knowledge acquired by students in the program. Students pay the $150 exam fee, and the Construction Management Department will repay the exam fee for those students who pass the exam. An analysis of Western Carolina University CM students' performance on the AC exam was completed, and the results were compared to national students' exam performance provided by the American Institute of Constructors.

The faculty of the CM program examined the tabulated results of students' performance on the AC exam. Generally, WCU's CM students scored below the national average. After investigating several potential reasons for this below average performance, it was found that there was a correlation with students' combined math and verbal Scholastic Aptitude Test (SAT) scores and AC scores. SAT scores were compared with corresponding AC exam scores for 160 construction management students at Western Carolina University, located in the southeastern United States with approximately 9000 total on-campus students.

The Construction Management program at Western Carolina University was established during 2002 and was accredited by the American Council for Construction Education (ACCE) during 2009. At the time of the study, the program included about 300 students. The department head completed a self-study report prior to accreditation that was, in effect, a detailed internal environmental

scan. Required program upgrades were noted at the time of the self-study report.

REVIEW OF LITERATURE

Background

There are several articles in the body of applicable literature that includes the CPC and AC exams in discussions of curriculum models and trends in the development of standard CM curriculums. The literature also provides examples of external program evaluation methods for CM program administrators.

McDaniel (2005) and Hauck (1998) discussed modern curriculum models of CM programs. Tinker and Burt (2005) and Kiisk (1998) discussed trends in the development of CM curriculums including integration of sustainable, green construction and cultural awareness, respectively. Bruce, Sauer and McCandless (2008) and Ferrntella (2002) discussed aspects of the CPC and AC exam applicable to CM programs.

Measuring Curriculum Effectiveness

McDaniel (2005) wrote about the difficulty in developing a CM curriculum that meets industry needs and accreditation requirements. He also wrote, "no longer should university faculty rely solely on accreditation requirements and their limited industrial experiences to develop curriculum" (p.8). National certification programs such as the AC exam are discussed as a component of external evaluation that supplement accreditation and faculty experiences. Comparison of an institution's student performance on the AC exam may well provide insight for CM program faculty nationwide to generate a continuous improvement plan for their program.

McDaniel (2005) also developed an integrated curriculum model for construction management educational program administrators, which included internal environmental evaluations to determine needed program revisions. The AIC provides statistical data measuring students' individual performance on the AC exam compared to students' performances nationwide. Educational administrators may use this statistical information to compare their program's performance to programs nationwide, providing another facet of an effective environmental scan.

Hauck (1998) wrote about external sources of appropriate learning outcomes for CM program administrators. The primary instrument discussed was the AC exam and the secondary source was ACCE accreditation. The AC exam is a ten-part test that is comprised of the following sections (American Institute of Constructors, 2009):

1. Communication skills including oral and verbal communications;
2. Engineering concepts including materials, soils mechanics, statics, and fluid mechanics;
3. Management concepts including contract types and ethics;
4. Materials, methods, and plan reading;
5. Bidding, estimating and quantity takeoff;
6. Budgeting, costs and cost control;
7. Planning, scheduling and control analysis;
8. Construction safety and Occupational Safety and Health Administration regulations;
9. Surveying and project layout; and
10. Project administration, procurement, and job site mobilization.

Specific course and program objectives may be tied to learning outcomes defined in each category above, which are also included in the appendix.

Curriculum Development Trends

Bruce, Sauer and McCandless (2008) discussed the benefits of the CPC and AC exam that are applicable to administrators of CM programs. In one study, they determined that approximately 34% of educators who were surveyed believed that CPC certification led to more recognition on their jobs, and increased their professional opportunities. Persons with the CPC designation were also perceived to have increased prestige among coworkers and increased confidence.

The only other significant applicable trend in curriculum development in the literature is in sustainable construction as discussed by Tinker and Burt (2005). They provide a definition of sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (p, 26). They state that governmental agencies and owners are demanding sustainability in construction projects. The Leadership in Energy and Environmental Design (LEED™) program administered by the United States Green Building Council (USGBC) is increasingly becoming the definitive standard for quality building. "The growth and importance of sustainable construction is undeniable (Tinker and Burt, 2005, p.29). The University of Florida, Texas A&M, Colorado State University and others have added environmental courses in their curriculum, and ACCE allows environmental coursework in their approved curriculum as well.

METHODOLOGY

Sample

As a part of an environmental scan, compiled data were examined to assess the performance of Western Carolina University CM students on the AC exam. There were 160 students at Western Carolina University who took the AC exam during the period from March 2006 to April 2010 who had also taken the SAT. Of these 160 seniors, thirty-seven (or 23%) passed the exam by scoring 210 points or

higher on the 300 point test. Approximately 67% of students who took the CPC exam nationwide passed the test during the April 2009 exam cycle. The average score for Western Carolina University's CM students was 185 while the national average score was 220. The faculty at Western Carolina University hope to improve the average exam scores and pass rates as the curriculum is developed to better meet program goals and to validate chosen student competencies.

The AIC, Constructor Certification Commission provides program administrators with detailed statistical information regarding student performance on each section of the AC exam. The Commission's report for Western Carolina University reflected student weaknesses in all ten sections of the exam.

Data Collection

SAT scores were available for 160 of the seniors who took the exam. SAT scores and AC exam scores were matched for the test group. Once the matched pairs of scores were tabulated, all names and identifying information were discarded. The data was organized as shown in Table 1. Thirty-seven students, or 23% of those included in the sample, passed the exam. Sixty-nine percent (69%) of Western Carolina University students who scored above 1200 on the SAT passed the exam. Of those who scored between 1100 and 1199 on the math/verbal SAT, about 46% passed the AC exam. Of those students with scores below 1100, only about 11% passed (Table 1).

Data Analysis

Western Carolina University CM students' AC exam scores and SAT scores were tabulated and graphed to look for trends. To determine if AC and SAT scores were correlated, a linear regression analysis was performed. There is a significant correlation (r = 0.60) between SAT scores and AC scores. A Pearson Correlation Coefficient (r=0.50) above 0.5 may be considered a large correlation (Cohen, 1988). Figure 1 shows that higher SAT scores resulted in higher AC exam scores and a greater probability of passing the AC exam. Any inferences from this data is limited to Western Carolina University CM students' performance and potential program improvements.

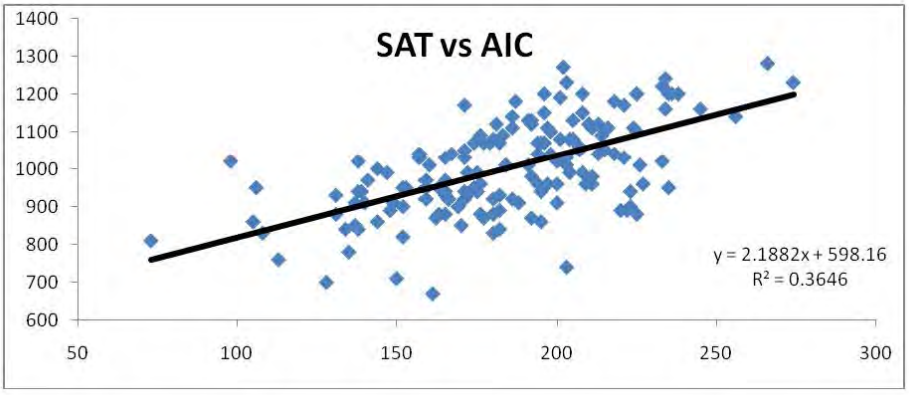
Results

The average SAT score for Western Carolina University CM students who took the AC exam was 1002. When regression analysis was applied to the AC scores and SAT scores of Western Carolina University CM students, it resulted in a correlation factor of 0.60 (r=0.60). This correlation indicates that 60% of the variation in AC exam scores earned by Western Carolina University's CM students may be explained by their combined math/verbal SAT scores.

TABLE 1: COMPARISON OF SAT SCORES AND NUMBERS OF STUDENTS WHO TOOK THE AC EXAM

	Passed	Failed	% Passed
<1000	9	72	11
1000-1099	7	33	18
1100-1199	12	14	46
1200+	9	4	69
Totals	37	123	23

FIGURE 1: AC EXAM SCORES VERSUS SAT SCORES



DISCUSSION

An examination of the performance of Western Carolina University's CM students on the AC exam results suggests that students who score below 1100 points on the math and verbal portion of the SAT have only about an 11% chance of passing the AC exam. In other words, about one in ten of these students may be expected to pass the AC exam. In addition, the average score for all of WCU's CM students taking the AC exam is 185 out of 300. A score of 210 is required to pass the exam. The faculty members at Western Carolina University hope to improve the average exam scores and pass rates by developing a curriculum that better meets program goals and that validates chosen student competencies in the CM program.

There are several steps which might be taken to improve CM student performance on the AC exam by the CM faculty at Western Carolina University One such step would be to recruit only students who score well on the SAT. The faculty could include AC exam preparatory materials in the curriculum or offer an AC exam test preparation course and require all seniors to attend the course. In general, the curriculum currently does not provide materials and activities that are specific to the AC exam. In addition, a general increase in the level of faculty member awareness of student performance in each test subject, especially in the areas they teach, might lead to more effective course materials that are related to test preparation and, therefore result in better student AC exam scores.

If only students with SAT scores above 1200 were recruited into the CM program at Western Carolina University, the pass rate for the AC exam for Western Carolina University's students might increase substantially as supported by the data in this discussion; however, this approach is unrealistic because Western Carolina University is a regional, comprehensive university serving a local populace. It is unlikely that the program could survive by enrolling only students who scored 1200 or above on the math and verbal portions of the SAT.

The faculty members of the CM Department could review the AC exam study guides and identify exam related materials to include in the courses they teach. For instance, most CM programs include a course in Statics. The AC exam includes materials related to Statics in Section II of the study guide that also includes Mechanics and Strength of Materials. Formwork design and beam load calculations are specific subject areas for which exam takers must be prepared. For instance, to properly prepare students, the professor who teaches Statics and Strengths of Materials at Western Carolina University should include formwork design and beam load calculations in his or her lectures and course materials.

Western Carolina University's CM faculty members have not emphasized AC exam preparation because the program is only eight years old and the curriculum is still being developed. ACCE accreditation was the primary assessment tool for program administrators prior to this study. If a preparatory course were provided for all CM seniors, the pass rate would likely improve. Fifty percent (50%) of Western Carolina University CM students scored above 185 points on the AC exam. Based on historical data, if these 185+ students were provided with additional academic boost to pass the exam by scoring 210 points, the overall pass rate for Western Carolina University on the AC exam would more than double. This could be a primary, short-term objective for the faculty members in the CM Department. A required one-semester credit hour, preparatory course could be used to address this objective. Students would receive a grade for their level of performance in this course that would count in their overall grade point average, possibly compelling them to allocate more time to test preparation.

Finally, all professors should be given feedback regarding their students' performance on parts of the AC exam pertaining to the courses they teach. A complete list of the AC exam subject areas is provided in Appendix I. Annual faculty member evaluations and promotions could be tied to students' performance. Professors and their supervisors could formulate fair, realistic goals regarding student performance on the AC exam in their pertinent areas of the curriculum. Students' scores in each area of the exam could be reviewed to determine if improvements have been made and new scoring goals could be established on a regular basis.

CONCLUSIONS

In conclusion, the 23% AC exam pass rate is well below the national average student pass rate of 67%. If the AC exam is to be used as a program assessment, the following steps are recommended to improve Western Carolina University's CM student performance:

1. Provide support for students to teach them about the test. A required course for all seniors would be the optimal scenario.
2. Provide students with AC exam familiarization in the pertinent areas of the program curriculum. Coursework could include AC related materials.
3. Provide instructors with feedback on student performance in their respective areas of the exam annually.

The faculty and administrators at Western Carolina University need to determine if the AC exam fits into their curriculum evaluation program and provide the necessary emphasis to meet the level of importance assigned to the AC exam. Additional studies of the factors contributing to successfully passing the AC exam should be undertaken by the faculty members at Western Carolina University.

REFERENCES

American Institute of Constructors, (2009). Certification Examinations for Level I. Handbook for Candidates. Retrieved on September 1, 2009 from: http://www.constructorcertification.org/btcp/download.htm

Bruce, R, Sauer, A. and McCandless, D., (2008). Comparing the impact of the Certified Professional Constructor (CPC) credential on the careers of construction educators and industry practitioners. Retrieved on September 1, 2009 from: http://ascpro.ascweb.org/chair/paper/CPRT218002008.pdf.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.)

Ferrntella, T. (2002). Construction certification prove yourself: Take the test. Engineering News Record, 4/1/2002

Hauck, A. (1998). Toward a taxonomy of learning outcomes for construction management education. Journal of Construction Education, 3(3), pp150-163.

Kiisk, L. (1998). Culture shock: Preparing students for globalization of the construction industry. Journal of Construction Education, 3(3), pp 213-222.

McDaniel, D., (2005). Developing an integrated curriculum model for construction management education. Retrieved on September 1, 2009 from: http://wed.siu.edu/Journal/volInum3/ConstructionManagement.pdf

Tinker, A. and Burt, R., (2005). Greening the construction curriculum. Retrieved on September 1, 2009 from: http://www.ascjournal.ascweb.org/journal/2004/no2/26-33.pdf

APPENDIX I

American Institute of Constructors Associate Contractor's Exam (AIC, 2009)

Areas of study

I. COMMUNICATION SKILLS

A. Oral Communication
1. Presentations, Telephone and Listening

B. Written Communications
1. Business Letters
2. Memorandums
3. Job Diary
4. Construction Reports
5. Meetings

II. ENGINEERING CONCEPTS

A. Engineering Material Properties
1. Aggregate
2. Concrete
3. Masonry
4. Steel
5. Wood

B. Soil Mechanics
1. Soil Composition, Types, and Properties
2. Soil Investigation Testing Methods and Soil Borings
3. Types of Foundations
4. Field Soil Identification Methods
5. Volume Changes and Compaction Methods

C. Mechanics and Strength of Materials
1. Formwork Design
2. Beam Loads

D. Air and Fluid Mechanics
1. Psychrometrics
2. Hydrology

E. Electricity

III. MANAGEMENT CONCEPTS

A. Contract Types
1. Elements of a Contract
2. Lump Sum
3. Unit Price
4. Design Build
5. Cost Plus
6. Construction Management

B. Business Entities
1. Sole Proprietors
2. Partnerships and Joint Ventures
3. Corporations and LLC

C. Accounting and Financial Ratios
1. Accounting Principles
2. Financial Reports and Ratios

D. Management Systems
1. Total Quality Management
2. ISO 9000 and Statistical Process Control
3. Partnering

E. Business Ethics
1. Constructor Code of Conduct
2. Bidding, Purchasing, and Professional Practice

IV. CSI MATERIALS, METHODS, PLANS/SPECS

A. Construction Equipment
1. Piling Equipment
2. Sheet Piling, Cofferdams, Tie-Backs
3. Excavation Equipment
4. Compaction Equipment
5. Cranes and Lifting Equipment

B. Plan/Schedule Reading
1. Sitework
2. Concrete and Forms
3. Rebar
4. Structural Steel
5. Carpentry
6. Exterior Finishes
7. Doors and Windows
8. Interior Finishes
9. Mechanical
10. Electrical

V. BIDDING AND ESTIMATING

A. Bidding Process
1. Bid Documents
2. Scales
3. Types of Specifications
4. Laws, Regulations, and Codes
5. Site Evaluation and Walk-Thru
6. Insurance and Bonds
7. Value Engineering and Life Cycle Costing
8. Temporary Site Layout

B. Estimates
1. Conceptual
2. Total Future Costs
3. Material Components
4. Equipment Productivity

C. Quantity Takeoff
1. Excavation
2. Forms, Rebar, Concrete
3. Rough Carpentry
4. Interior Finishes

VI. BUDGETING, COSTS, AND COST CONTROL

A. Budgeting
1. Work Breakdown Structure

B. Cost Control
1. Productivity Rates, Earned Work hours
2. Unit Costs
3. Forecasts at Completion

C. Finalize Costs
1. Retainage
2. Back Charges
3. Payments

VII. PLANNING, SCHEDULING, AND CONTROL

A. Logical Sequences of Design, Procurement, and Construction
1. Multi Crew, Phase Durations, Activity Durations, and Effective Durations

B. Event Times, Calculations, and Scheduling Terminology
1. Leadtime, Forward Pass, Backward Pass
2. Total Float, Free Float, ES, EF, LS, LF, Critical Path(s), Completion Time

C. Schedule, Analysis
1. Crashing & Impact

VIII CONSTRUCTION SAFETY

A. OSHA Administrative
1. EMR
2. General Duty Clause
3. Site Procedures, MSDS
4. Competent Person and Due Diligence

B. Standard Safety Procedures
1. Handrails
2. Ladders
3. Fire Extinguishers
4. Excavations Set Backs, Travel Distances
5. Recordkeeping and Employee Posters

APPENDIX I

American Institute of Constructors Associate Contractor's Exam (AIC, 2009)

Areas of study CONTINUED

C. Safety Procedures Interpretation
1. Sloped and Shored Excavations
2. Scaffolding
3. Personal Protection
4. Electrical Protection

IX. SURVEYING AND PROJECT LAYOUT

A. Equipment
1. Tapes, Plumb Bobs, Level Laser, Batter Boards

B. Topography Map
1. Contours

C. Calculations
1. Horizontal Distances
2. Vertical Control Elevations

X. PROJECT ADMINISTRATION

A. Procurement of Resources
1. Subcontractors
2. Materials
3. Equipment

B. Duties/Responsibilities
1. Construction Management and Engineering Job Descriptions
2. Organizational Chart
3. Design, Procurement, and Construction Team
4. Craft Trade Descriptions

C. Job Site Mobilization
1. Site Layout Considerations
2. Shop Drawing, Product Data Submittal, and Review Process
3. Contract Clauses, Changes, Claims, Dispute Methods
4. Quality Control, Inspection, and Government Regulations

D. Job Site Administration
1. Human Resources
2 Project Documentation

E. Project Closeout
1. Punch Lists, Substantial Completion, Occupancy
2. Documentation Turnover
3. Final Payment/Completion