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The **University Aviation Association** is the only professional organization representing all levels of the non-engineering/technology element in collegiate aviation education. Working through its officers, trustees, committees and professional staff, UAA plays a vital role in collegiate aviation and the aviation industry.

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Ballard M. Barker, Ph.D., A.A.E
Editor

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ACADEMIC INTEGRITY IN HIGHER EDUCATION: IS COLLEGIATE AVIATION EDUCATION AT RISK?

Jeffrey A. Johnson
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Abstract

Academic integrity needs to be an integral part of collegiate aviation education if students expect to effectively compete in this highly competitive field. Academic integrity is a serious problem in most US colleges and universities today and student dishonesty (in the form of cheating) has presently risen as a major contender for instructors' attention. Recent studies have revealed 40% to 90% of all US college students cheat. To presuppose that academic integrity issues are of little importance and do not present serious problems to collegiate aviation could, in time, irrevocably compromise its very foundation. This paper discusses academic integrity and legal issues in higher education, with implications for collegiate aviation.

Introduction

Collegiate aviation faculty, administrators, and students are not exempt in the ongoing battle of maintaining academic integrity in the realm of US higher education. Academic dishonesty has been a well documented problem at colleges and universities (Barnett & Dalton, 1981; Hale, 1987; Stevens & Stevens, 1987) that seems to be worsening. The term, *academic dishonesty*, has been defined by Gehring and Pavela (1994) as:

> an intentional act of fraud, in which a student seeks to claim credit for the work or efforts of another without authorization, or uses unauthorized materials or fabricated information in any academic exercise. [Academic dishonesty] also includes forgery of academic documents, intentionally impeding or damaging the academic work of others, or assisting other students in acts of dishonesty. (pp. 5-6)

Gehring and Pavela (1994) have categorized academic dishonesty into four distinct areas:

Cheating: Intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise.

Fabrication: Intentional and unauthorized falsification or invention of any information or citation in an academic exercise.

Facilitating academic dishonesty: Intentionally or knowingly helping or attempting to help another to commit an act of academic dishonesty.

Plagiarism: Intentionally or knowingly representing the words of another as one's own in any academic exercise. (pp. 12-13)

Although collegiate aviation is still a relatively young discipline, academic integrity issues are presenting formidable challenges that have plagued traditional fields of study for quite some time. Research conducted by the Carnegie Council (1979), Levine (1980), and Pavela (1981) indicate that present-day college students value achievement and the ability to compete successfully versus independent scholarship. Most programs in the aviation sciences(e.g., flight and maintenance technologies, aviation management and administration) are highly competitive by nature and the environment alone may be enough to entice some students to cheat. (e.g., flight and maintenance technologies, aviation management and administration) are highly competitive by nature and the environment alone may be enough to entice some students to cheat.

Perhaps what is most disturbing of all, cheating is also prevalent in academic and professional disciplines that could adversely affect the quality of human life. For example, in a research study involving two medical schools, Sirles, Hendrickx, and Circle (1980) found that 87.6% of sampled premedical students and 58.2% of medical students reported cheating. Like premedical and medical programs, collegiate aviation has much to lose if academic integrity issues are not taken seriously. According to Benton (1995), "the safety of the aviation industry depends on the ethical and professional conduct of the people involved in the industry, yet the topic of ethics is strangely absent in the curricula of many university aviation programs" (p. 22). Curricula is already strained in the aviation field and is not readily receptive to incorporating additional courses such as ethics (Benton, 1995).

Higher Education: A Crisis in Values

As American colleges and universities approach the Twenty-First Century, an underlying factor eroding academic integrity is a crisis in values. A recent study completed by 16 representatives from education, business, and nonprofit organizations known as the Wingspread Group on Higher Education (1993) revealed some very disturbing trends in higher education:

> The nation's colleges and universities are enmeshed in, and in some ways contributing to, society's larger crisis of values. Intolerance on campus is on the rise; half of big-time college sports programs have been caught cheating in the last decade; reports of ethical lapses by administrators, faculty members and trustees, and of cheating and plagiarism by students are given wide-spread credence . . . . The weakening of the role of family and religious institutions in the lives of young people, the increase in the number of people seeking the benefits of higher education, and what appears to be the larger erosion of core values in our society make this traditional role all the more important. (p. 4)

A crisis in values in American higher education can be partially attributed to changes in student values. Gehring and Pavela (1994) found that students engage in academic dishonesty because "the ability to succeed at all costs is one of the most cherished values. Students are more interested in financial security, power, and status and less committed to altruism, social concerns, and learning for the sake of learning" (p. 9).

Perceptions of Academic Dishonesty

Students cheat for a variety of reasons and sometimes engage in acts of academic dishonesty without even realizing it. Gehring and Pavela (1994) noted in their research that a frequently cited reason students engage in cheating is a lack of awareness of how academic dishonesty is defined and what constitutes academic dishonesty. This notion is exemplified by research study results (see Table 1) of the perceptions of students and faculty concerning discrepancies in perceptions of cheating (Graham, Monday, O'Brien, & Steffen, 1994).

Table 1

Percent of Students and Faculty who View Behavior as Cheating and Percent of Students who Report Having Engaged in Each Behavior

Behavior	Percent of students view cheating*	Percent of faculty view cheating*	Percent of students have done behavior
Looking at notes during a test	99.6	100.0	25.8
Arranging to give or receive answers by signal	98.9	100.0	4.5
Copying during an exam	98.9	100.0	26.0
Taking a test for someone else	93.5	100.0	2.7
Asking for an answer during an exam	98.2	100.0	26.0
Giving answers during an exam	97.9	100.0	20.6
Copying someoneelse's term paper	97.2	100.0	13.7
Allowing a student to copy on a test	96.0	100.0	23.5
Having someone write a term paper for you	95.9	100.0	97.9
Finding a copy of an exam and memorizing the answers	95.1	100.0	17.1
Writing a paper for someone else	93.6	100.0	9.5
Giving test questions to a student in a later session	86.9	97.9	49.6
Not contributing a fair share in a group project	79.4	79.6	36.4
Allowing someone to copy homework	74.6	83.0	63.1
Using an old test to study without the teacher's knowledge	66.0	83.3	37.5
Using a paper for more than one class	45.9	77.1	53.6

Note. *Percent who responded that the behavior was not very severe, severe, or very severe form of cheating. From "Cheating at Small Colleges: An examination of Student and Faculty Attitudes and Behaviors," by M. Graham, J. Monday, K. O'Brien, and S. Steffen, 1994, *Journal of College Student Development*, 35, p. 256.

This research study also revealed that faculty and students agree on the top three reasons why a student would cheat. The reasons faculty and students report that students cheat is that: **(a)** they need a better grade (students 72.5% and faculty 84.5%), **(b)** they did not have time to study (students 60.4% and faculty 69.9%) , and **(c)** they saw an opportunity and just took it (students 33.5% and faculty 61.5%) (Graham, Monday, O'Brien, & Steffen, 1994).

Legal Implications of Academic Integrity

In a highly litigious society, cases of academic dishonesty occasionally end in the courts although the practice is not highly prevalent. According to Gehring and Pavela (1994), faculty are often reluctant to report alleged acts of academic dishonesty because they fear an impending lawsuit. This reaction "stems from the unfounded belief that if they report an alleged act of academic dishonesty, the student will be exonerated since it is only the faculty member's word against the student's and having been exonerated, the student will then bring suit for defamation" (p. 16). In this scenario, faculty and administrators are protected by their "qualified immunity/privilege" status (*Vargo v. Hunt,* 1990).

In addition to faculty reluctance, the courts do not typically view alleged cases of academic dishonesty as "desirable" cases. According to Kaplin and Lee (1995), the courts are generally reluctant to get involved in academic disputes involving matters of course content, teaching methods, grading, or classroom behavior. The courts view these responsibilities as belonging to educators and administrators. Cases involving academic dishonesty at colleges and universities are academic matters. The courts have found that faculty and administrators must comply with the hearing panel's findings and decisions made in academic dishonesty cases on the campus. In *Lightsey v. King* (1983), a midshipman from the U.S. Merchant Marine Academy brought action for declaratory and injunctive relieve against the Academy for its refusal to change the grade of "zero" after the midshipman was exonerated of cheating by the academy's honor board. As a result, the court found that by holding the honor board hearing and then disregarding its result, the Academy had violated the midshipman's right to due process.

If an alleged case of academic dishonesty is tried in court, faculty members are afforded some protection. In *Hall v. Medical College of Ohio* (1984), a former medical student who was dismissed from school because of alleged academic dishonesty appealed from summary judgment entered by the United States District Court in favor of the Medical College of Ohio. After reviewing the case, the Sixth Circuit US Court of Appeals affirmed the decision of the lower court and held that: **(1)** the medical school was an arm of the state and thus immune from suit brought by the discharged student; **(2)** school officials were entitled to immunity from liability for damages in their individual capacities; and **(3)** since the school had good cause for expelling the student, his expulsion was not caused by a due process violation that may have occurred when he was denied assistance of legal counsel at his disciplinary hearing.

In *Jaska v. Regents* (1984), a university student who was suspended for one term for cheating on a final examination brought suit against the president, dean, and regents of the university alleging that he was denied procedural due process. The student argued that he was not allowed representation at the hearing, was not given a transcript, could not confront the student who reported the cheating, and did not receive a detailed statement against him. The court found that the student had a liberty and a property interest in continuing his education at the university, although the court rejected the student's claim that his due process was violated. The court ruled in favor of the regents and found that, although the student was entitled to procedural due process, the fact that some procedures specified in the university's disciplinary manual were not followed did not deny the student due process.

In both cases (*Hall v. Medical College of Ohio*, 1984 & *Jaska v. Regents*, 1984) similarities exist in respect to students accused of cheating. The courts have said that students accused of violations of academic integrity are entitled to the higher level of due process procedural protection guaranteed in school *disciplinary* proceedings rather than the level of protection afforded in *academic* matters (Constitutional Law 278.5(7), cited in *Jaska v. Regents*, 1984). A school's disciplinary proceeding is not a criminal trial, and a student accused of cheating is not entitled to all the procedural safeguards afforded criminal defendants (Colleges and Universities 9.35(4), cited in *Jaska v. Regents*, 1984).

Faculty Perspectives in Addressing Academic Dishonesty

Collegiate aviation faculty, like those in other fields of study in higher education, need to be consciously aware and actively involved in reducing academic dishonesty. Historically, institutions of higher education have handled academic dishonesty from a moral perspective by using and enforcing honor codes (Kibler, 1994), although many of these institutions have replaced honor codes with administrative disciplinary systems (Hardy, 1982; Kibler, Nuss, Paterson, & Pavela, 1988). Gehring, Nuss, & Pavela, 1986; Georgia, 1989; Pavela, 1981, Rutherford & Olswang, 1981; and Kibler et al. (1988) proposed that academic dishonesty prevention must begin at the institutional level. Research from Geist, Fagan, Hardy, Singhal and Johnson (as cited in Gehring & Pavela, 1994) provides effective strategies for faculties to combat academic dishonesty:

- Develop course objectives and tie all tests and assignments to those objectives. Unrealistic, trite, or irrelevant assignments provide students with a rationale to be dishonest.

- Faculty members should know their students and their capabilities. Frequent written assignments and testing will provide an opportunity to learn the kind of work students are capable of performing. Students who know that faculty members are aware of their abilities are less inclined to substitute the work of others as their own. Courses in which there is only one examination or paper put excessive pressure on students to perform. This type of "all or nothing" environment breeds academic dishonesty.

- Faculty members should use part of the first class session to review university standards and let students know why academic integrity is important. Members of a student honor council, or academic integrity advisory committee, could also be invited to make a brief presentation.

- The course syllabus should contain a statement alerting students to the institution's academic integrity policies and affirming the teacher's intention to abide by them.

- A pool of test questions should be developed that would permit changing tests each term.

- Teachers should supply official examination booklets at examinations.

- "Take home" examinations or lab assignments should be avoided, unless student collaboration is desired.

- The use of standard examinations contained in teachers' manuals should be avoided, since resourceful students are often able to obtain such publications.

- Students should be informed that they will not need anything for the test except a pen or pencil. All other materials must be left outside of class or at the front of the room.

- Students in large classes should be required to show proper identification before taking examinations.

- Students should be expected to write their names on examination booklets in ink.

- Both questions and answers on short-answer examinations should be scrambled, especially in large classes.

- Students might be seated randomly in examinations, but exam booklets should be numbered and gathered by row, so seat location can be determined. It is especially important to prevent groups of students from entering the room together and sitting near each other.

- Examinations must be carefully and diligently proctored by an adequate number of proctors, unless an effective "honor code" has been adopted.

- Faculty members should consider allowing students to make handwritten notes on a 3" x 5" card for use during examinations. This procedure helps students organize what they have learned, and reduces the temptation to rely on "crib" sheets.

- Graduate assistants or student graders must not be given a solutions manual for the entire course.

- Students might be informed before the examination that significant numbers of completed examinations are photocopied before being returned. Such a practice may discourage students from altering returned examinations and submitting them for regrading.

- Students assigned to write substantial papers might be asked to give a relevant oral presentation to the class and respond to questions from the teacher and other students. Such a practice has the educational value of giving students some additional experience in speaking before a group. Also, students assigned to write substantial papers might be required to meet at least once with the instructor to review the topic and discuss the ongoing research which the student has undertaken.

- Instructors might require that an outline and a first draft be included when students submit major papers. (pp. 13-16)

Additional strategies for collegiate aviation educators (see Table 2) include the reliance on oral examinations during aviation related activities. If properly administered, oral examinations not only have the advantage of reducing or eliminating academic dishonesty, but can challenge students' ability to apply what they have learned (a disadvantage of passive, lecture-style environments). For example, flight students enrolled in upper level courses (e.g., turbine aircraft systems and operations) could be tested in a predetermined simulation exercise involving their psychomotor and oratory skills. At appropriate times throughout the simulation, the instructor could ask questions and have the student explain the material. In aviation administration courses, instructors could set aside individual time with each student, give the student a one page written case study on improving airport security at a given airport and ask the student questions, give explanations, and defend their rationale during the oral examination. It would not take a faculty member a great deal of time to determine if the student has a thorough understanding of the material, by assessing each student's responses.

Table 2

Strategies for Collegiate Aviation Faculty Members in Reducing Academic Dishonesty and Improving Instructional Effectiveness

INSTRUCTIONAL STRATEGIES
1. Oral examinations 2. Intructor/student simulations 3. Encourage student collaboration during out of class "real world" projects 4. Sign an academic integrity agreement form and learning contract with students 5. For student co-ops, require a journal of the student's daily/weekly activities unique to the activity site while monitoring the student's performance through the co-op supervisor

Although most faculty consider student collaboration outside of class as cheating, this mind set is antagonistic to the principles that employers espouse to their employees. Encouraging student collaboration in meaningful, "real world" projects prepares students for the realities of the aviation/aerospace industry after graduation. In a global society where the emphasis is placed on teamwork and team-oriented tasks, out of class student collaboration can be effectively utilized to achieve those ends while individualistic assignments can be handled in-class or by other means.

Another method of reducing academic dishonesty is to sign an academic integrity agreement and a learning contract with each student. During the first class meeting, the instructor needs to explain the policies outlined by the institution for cheating and other forms of academic dishonesty in addition to outlining the penalties for such actions (Singhal & Johnson, 1983). A learning contract specifically outlines the learning objectives as agreed upon by the student and the instructor for the course. Both of these "contracts" will enhance communication effectiveness between both parties.

For students involved in cooprerative education (co-op), requiring the student to keep a daily/weekly log of the experiences while maintaining regular and effective communication with the co-op supervisor can provide a means of reducing academic dishonesty. By maintaining a communication outlet between instructor and the co-op supervisor, the instructor can verify actual experiences with entries in the student log under the direction and leadership of the co-op supervisor.

Conclusions

Academic dishonesty is a serious problem in American colleges and universities, and seems to be getting worse. Prevalent acts of cheating have affected the professional fields such as medicine (Sirles, Hendrickx, and Circle, 1980). This seems to draw suspicion that if undergraduates cheat, they will continue to cheat in medical school and in the professional world as physicians. In collegiate aviation, strong ethical and professional conduct affects the safety of the aviation industry at large (Benton, 1995) and, like the medical field, condoning cases of academic dishonesty in the classroom may very well lead to cheating and other "short cuts" in the professional world.

Cheating in the professional world of aviation may lead to loss of life. Consider the aviation student who may cheat when it comes to departing when the weather is marginal as a student pilot, the airport administration student who cheats in a class project when designing a secure, weapon-free "sterile area," and the aviation maintenance technology student who cheats on performing acceptable aircraft repair methods. Can collegiate aviation educators make an assumption that dishonest behavior will cease once these students enter their respective professions in the aviation industry as the next generation of airline/corporate pilots, airport administrators, and aircraft maintenance technicians?

Collegiate aviation educators must become *active participants* in the effort against academic dishonesty in higher education if students are expected to perform at their best in school and in the labor force. To actively instill strong ethical and moral values in the classroom is paramount. The finest collegiate aviation programs will fall short of meeting high expectations of its graduates because ". . . the best educational experience should be taught in the context of values. The acknowledgment of our values with respect to ethics, family, religion, and society is a key point and should be a framework for our daily life" (Lehrer, 1995, p. 6). The decisions that collegiate aviation educators make, or fail to make, regarding academic integrity have widespread and long-lasting repercussions not only on their students, but on the people they serve as well.

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AVIATION/AEROSPACE FORECAST 2005: INDUSTRY AND EMPLOYMENT OUTLOOK

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Abstract

This paper briefly examines the current economic status of the aviation/ aerospace industry, its projected growth to the year 2005, and the prospects for different aviation-related careers during the next decade. Since 1960, the industry has faced a series of boom and bust cycles. As a result of programs to severely cut airline costs, a healthy economy, and continued airline traffic growth, the financial picture for the industry in the decade ahead looks better than it has since 1989, although not all analysts agree on the scope and profitability of that growth. These industry changes, coupled with technological advances, will alter the industry and its workforce requirements. New scientific and management skills will be required. Finally, the paper examines the anticipated demand for personnel in various aviation/aerospace fields from 1995 to 2005.

Introduction

The highly diverse aviation and aerospace industry in the United States not only serves the traveling public and the world's defense establishments, but it has considerable impact on the U.S. economy as a source of employment. It is closely linked to the nation's economic cycle, and since 1960 labor demands have shifted cyclically between critical shortage and excess supply. Depending on the cycle of boom or bust, the industry employs between 750,000 and 1.3 million pilots, mechanics, engineers, computer scientists, reservation clerks, and other specialists (Oklahoma Regents, 1994). This paper examines briefly the current economic status of the aviation/aerospace industry, its projected growth to the year 2005, and the prospects for different aviation/aerospace related jobs during the next decade.

Industry Trends

Since 1960, the U.S. commercial airline industry has faced a series of boom and bust cycles. The boom years correspond to an expansionist economy and stable or declining oil prices while the bust cycles reflect a recessionist economy and high oil costs. Prior to 1994, the last year the industry reported a profit was 1989 when carriers reported a gain of $128 million (Velocci, 1995). In the intervening years, the industry lost $3.0 billion in 1990, $1.9 million in 1991, $4 billion in 1992, and $2.1 billion in 1993 (Velocci, 1995). All major passenger carriers except Southwest Airlines suffered losses, Eastern and Pan American were liquidated, and three additional major airlines filed for bankruptcy protection.

The picture changed in 1995. As a result of competitive pressure, every major airline launched a program to severely cut costs. These programs included restructuring operations, reducing excess capacity, withdrawal from unprofitable routes, retiring inefficient aircraft, reducing food service, and shifting to ticket less reservations and booking, among other measures (Murphy, 1995). In addition, the three airlines under bankruptcy protection have emerged from Chapter 11 proceedings. Coupled with a healthy economy, the major airlines showed a profit of $2.4 billion in 1994 (Murphy, 1995). In 1995, U.S. commercial airlines made $5.3 billion dollars, the most profitable year ever (Hinson, 1996b). These trends are continuing in 1996.

Table 1
Airline Industry: Boom/Bust Cycle

Cycle	Years	Duration	Industry
Boom	1960-68	9	Jet Age; Mass Travel
Bust	1969-74	6	Wide-body Ear; Excess Capacity
Boom	1975-79	5	Defacto Regulation
Bust	1980-82	3	Deregulation
Boom	1983-89	7	Mergers and Acquisitions
Bust	1990-94	5	Overcapacity; Hypercompetitive Environment; Growing Debt
Boom	1995-2000	6	Opeating and Financial Restructing to Reduce Costs and Improve Profits; Higher Load Factors

Note. Adapted from Anthony L. Velocci, 1994, Aviation Week & Space Technology, 142(110, p.45.

Simultaneously, the U.S. aerospace industry suffered a downturn in its defense market. Aerospace sales to the U.S. military fell almost $30 billion since 1987 while those to foreign customers declined as well (Vadas, 1995). The dramatic decline in world arms deliveries has been precipitated primarily by the end of the Cold War, political and economic upheaval in Russia that ended foreign-aid-supported military exports, and limited national budgets in developing countries that restrict government military spending (Lopez, 1994). Between 1987 and 1993, 60% of the defense-related jobs lost, 989,000 positions, were in the private sector. The remaining 40% were in the Armed Forces and Pentagon (Saunders, 1995). By 1999, the Bureau of Labor Statistics projects that defense-related employment will have fallen an additional 1.3 million, to 4.3 million (Saunders, 1995).

Table 2
Projected Defense-Related Employment by Selected Industry, 1993 and 1999 (thousands of jobs)

Industry Employment	1993	1999, Projected	Projected Decline 1993 to 1999
Total Defense- Related	5,595.3	4,289.8	1,305.5
Aircraft	111.9	78.6	33.3
Guided Missiles and Space Vechicles	76.3	53.7	22.6
Aircraft and Missile Parts	82.4	64.4	18.0
Aircraft and Missile Engines	64.6	47.5	17.1
Search and Navigation Equipment	59.1	43.3	15.8
Communications Equipment	42.2	1.1	41.1
Miscellaneous Electronic Components	47.8	36.8	11.0

Note. Adapted from Norman C. Saunders, 1995, Occupational Outlook Quarterly, 39 (2), p. 33.

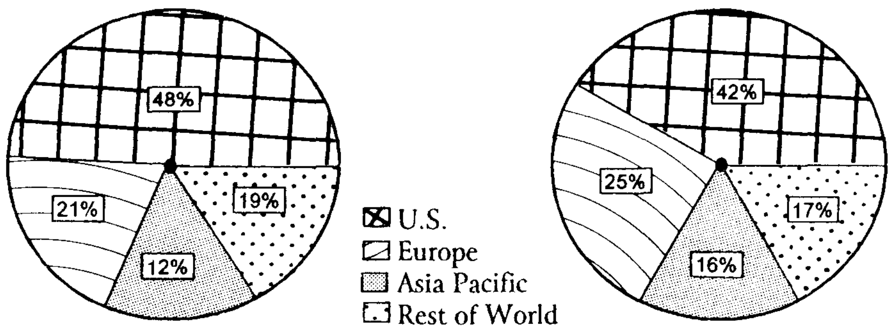
Industry Growth Prospects

Major growth in the airline industry is expected in the commercial market, although not all analysts agree on the scope and profitability of that growth. The airline industry's financial prospects are dependent both on the overall growth of the economy and on continued airline traffic growth, itself a function of the economy. The U.S. Office of Management and Budget forecasts the growth of Gross Domestic Product at approximately 2.6% between 1995 and 2001, and 2.4% from 2002 to 2005 (Murphy, 1995). With these economic forecasts as a basis, the Federal Aviation Administration (FAA) projects that current strong airline traffic growth rates will continue for the next two years, and then continue at a healthy 4.2% through 2005. The FAA foresees airline traffic of 537 billion route passenger miles in 1995, 567 billion in 1996, and 869 billion by 2006 (Murphy, 1995). In addition, the FAA is forecasting that the number of commuter passengers will increase from approximately 58 million in 1995 to 174 million over the next 12 years (Hinson, 1995a). As the number of passengers increase, the FAA estimates that the commercial aircraft fleet will expand from 6,605 in 1995 to 9,781 in 2006 (Murphy, 1995; BNA, 1995). Air cargo is projected to grow an average of 6.6 % annually over the next decade (Hinson, 1996a). "To handle this heavy volume of passengers and cargo, airlines will have to double the size of the existing fleet, buying 15 to 17 thousand new planes by the end of 2016...Aircraft deliveries are expected to double by the year 2002 or 2003, then double again within 20 years" (Hinson, 1996a, 1996d).

With cost reductions and continued strong growth in airline traffic, the airlines' operating profits will rise. The emerging consensus among industry analysts is that all components of the commercial airline industry are on the rise. For example, Aviation Information Resources, Inc.

forecasts the world's aircraft fleet to grow from 9,800 aircraft in 1990 to over 15,700 by 2005, a 61% increase (Oklahoma Regents, 1994; Sparaco, 1994). They also project the U.S. jet fleet to increase from 4,720 in 1990 to 6,519 in the year 2005, a 38% increase (Oklahoma Regents, 1994; Kandebo, 1995). Asia and the Pacific are forecast to be the fastest growing regions with 1,224 aircraft in 1990 expanding to 2,534 aircraft in 2005, a 108% growth (Meecham, 1994). Europe, on the other hand, is expected to grow from 2,045 aircraft in 1990 to 3,977 by 2005, a 94% fleet growth (Shifrin, 1995). Almost every major U.S. carrier is now in the international market carrying approximately 50 million passengers a year. This represents an increase of 30% in the last five years (Hinson, 1995b).

Figure 1
The World's Aircraft Fleet



1990 World Total
9,800 Aircraft

Projected 2005 World Total
15,700 Aircraft

Technological Needs

Coupled with the growth trends, are also technological trends that will alter the industry and the work force. These include such changes as: **a)** larger commercial aircraft size resulting in the need for airport redesign and new systems of ground transportation; **b)** faster travel at higher altitudes resulting in the need for new materials that are stronger and lighter; and **c)** on-board maintenance systems that will result in electronically displayed data rather than data displayed on paper (Oklahoma Regents, 1994). As technological advances continue, the aviation/aerospace work force will, among other things, be required to possess skills in working with computer based equipment and information systems. Engineers and technicians will be needed who have skills in more than one discipline, are able to synthesize what they have learned, are creative and approach problems in different ways, use different methods to obtain solutions to a problem, and work together in cohesive team-oriented groups. They need practical hands-on activity that emphasizes engineering judgement and design capability.

Similarly, the work force will be required to work at a rapid pace in a world focused on low prices, reliability and rapid product changes. This type of work environment will require aviation/aerospace employees to understand and utilize management principles with a heavy emphasis placed on statistical process controls. Further, technological improvements will require the work force to have strong academic underpinnings in basic skills such as mathematics, science, and communication, in addition to having improvements in interdisciplinary knowledge and the applied sciences (Ladesic & Hazen, 1995; Maul, 1994).

Employment Needs and Job Opportunities

Total employment in the U.S. is expected to increase from 121.1 million in 1992 to 147.5 million in 2005, or by 22% (BLS, 1994b; Gradler & Schrammel, 1994). The Bureau of Labor Statistics (BLS) predicts that 26.4 million jobs will be added to the U.S. economy by 2005. Those jobs will be created in three ways: growth, upgrading, and replacement needs (Shelley, 1994). These avenues are expected to create close to a million jobs annually for college graduates between 1995 and 2005 (Shelley, 1994; Gradler & Schrammel, 1994). More than half the new and upgraded jobs will be in professional specialty occupations. These include positions such as engineers; computer systems analysts and programmers; operations research analysts; and in various communications occupations, among others. As a whole, this group is expected to continue to grow faster than average and to increase its share of total employment significantly by 2005 (Oberman & Nagle, 1995). Rapid changes in technology, demographics, and ways of conducting business will cause some of these occupations to grow faster than others (BLS, 1994b).

What are the future employment needs and career opportunities in the diverse aviation/aerospace industry? The job prospects for the year 2005 in some of the areas are outlined briefly below:

Airline Pilot

Money magazine's 1995 job report ranks 50 skilled professions that are projected to grow fastest by the year 2005, one of those positions is that of airline pilot (Marable, 1995). Both the Federal Aviation Administration and the BLS predict major demands for new pilots in the next ten years. The FAA forecasts that a total of 157,500 airline pilots will be needed by 2005 (Field, 1995; Wilhilmsen, 1995). Between December 1993 and December 1994, the airlines hired about 8,300 new pilots, an increase of 45%. If the recent trend of increased hiring continues at the same time that the number of new student pilots stay low, airline and general aviation will face a shortage according to aviation industry executives (FAA, 1993).

Aircraft Maintenance Technicians and Engineers

In 1992, 10,636 aircraft maintenance technicians and engineers were hired; the number of new hires in 2005 is projected by the FAA to be 16,235 for the airlines and another 4,000 for general aviation, resulting in a 35% increase. If the FAA's projections are accurate, the need for maintenance technicians and/or engineers will grow twice as fast as the average for all occupations (2.5 vs. 1.3% annually). Approximately 220 schools in the U.S. operate under FAR Part 147 certificates producing an estimated 20,000 technicians with entry-level Airframe and Powerplant certificates (FAA, 1993). Of the 220 schools, 67 offer associate and baccalaureate degrees and graduate approximately 3,000 students annually (FAA, 1993). According to a recent FAA study there will be an inadequate supply of technicians and engineers since specialized training required to work on newer aircraft can only be received at a few schools (FAA, 1993).

Computer Scientists

Computer systems analysts, computer engineers, and programmers held about 555,000 jobs in 1992. These individuals are employed in many different industries. Employment opportunities are expected to grow faster in all other occupations through the year 2005, and the supply of programmers is not expected to meet the demand (Gradler & Schrammel, 1994). Important areas of growth will be in data communications, expert systems, the use of computer-aided software engineering tools, and the development and maintenance of data base management systems. Not unsurprisingly, given the growing use of computers, four of the 50 fastest growing positions in *Money's* survey are computer related (Marable, 1995).

Engineers

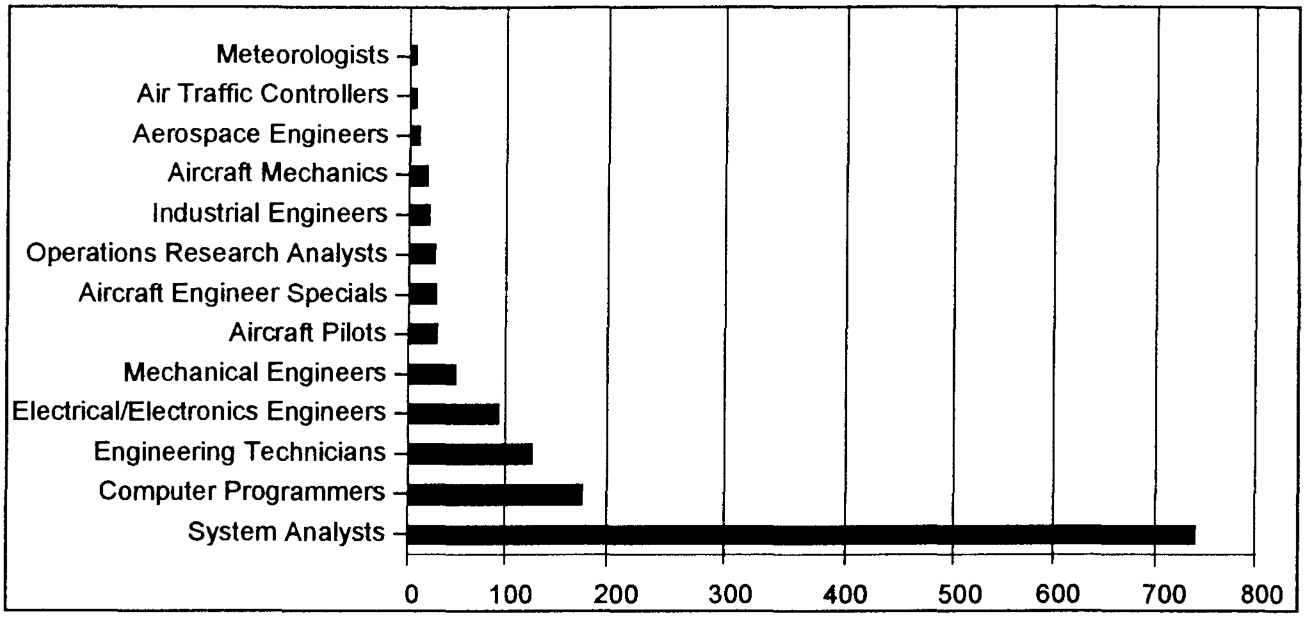
More than 25 major specialties in engineering are recognized by the professional societies, with numerous subdivisions in the major branches. In 1992, engineers held 1,354,000 jobs, with just under one-half of these jobs in the manufacturing industry (BLS, 1994a). Electrical engineers account for 26% of all engineers, mechanical engineers make up 17%, and another 8% are aeronautical engineers. (BLS, 1994a).

Employment opportunities in engineering disciplines have been good for a number of years, and the trend is expected to continue through the year 2005 (BLS, 1994a). The computer, quantitative, and problem solving skills of engineers are in demand in almost any industry. Good job opportunities will continue because the number of jobs will grow while the number of degrees awarded in engineering is expected to remain near present levels through the year 2000 (BLS, 1994a; Gradler & Schrammel, 1994). Engineering jobs will shift from defense-related work to other areas, primarily to the design and manufacturing of goods and services including the production of flight instruments and displays, radar instrument and microwave landing systems, and geosynchronous satellite communications. Through the year 2005, the demand for electrical and mechanical engineers is expected to equal the supply, while the number of aerospace engineers is expected to exceed the demand (*ASME News,* 1996; Gradler & Schrammel, 1994).

Meteorologists

Meteorologists held about 6,100 jobs in 1992 (BLS, 1994a). The largest employer of civilian meteorologists is the National Oceanic and Atmospheric Administration which employs about 2,400 meteorologists; most of these individuals work for the National Weather Service (BLS, 1994a). Other meteorologists work for private weather consultants, research and testing services, and computer and data processing services. Employment of meteorologists is expected to grow as fast as the average for all occupations through the year 2005, due to expected increases in employment in the National Weather Service's field offices and increased use of private weather forecasting services (Gradler & Schrammel, 1994).

Table 3
Projected Employment Change for selected Aviation/Aerospace Related Occupations, 1992-2005 (thousands)



Conclusion

The prospects for the growth of the commercial airline industry, although not for the defense and government sectors, look very positive. The airline industry is restructing itself into a more efficient, highly competitive, and low-cost service industry. Every major airline has launched a program to cut costs. coupled with a growing economy and an increased number of airline passengers, the airlines are expected to show strong operating and net profits. As the number of passengers grow, the size of the world's commercial fleet growsalso. Correspondingly, the job prospects for those pursuing aviation and aerospace careers, providing they develop appropiate skills, looks better than it has in recent years.

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TECHNOLOGY IN THE AVIATION METEOROLOGY CLASSROOM: A PILOT STUDY

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Abstract

Over the past few years, advanced technology that provides interactive and current weather data has become available in the aviation meteorology classroom. As part of its Airway Science Program, the Federal Aviation Administration has helped finance the installation of this technology at colleges and universities with aviation programs. The new systems were to be used in a dual role, as both an instructional aid and a flight planning tool. This study explores the efficacy of the technology as an aid to instruction by comparing students who had access to the technology to those who did not. The technology was used to provide relevant background material on a topic before the topic was formally presented in the course (a term frequently used to describe such background material is 'advance organizer'). Next, in order to statistically match study subjects, predictor variables for success in a basic aviation meteorology course were determined. Last, a pilot study was conducted with students who had access to the technology, comparing their success to those who did not. The encouraging results of this pilot study were reported to the FAA in an institutional Airway Science grant report.

Introduction

The past several years have seen the introduction of technology into the meteorology classroom (Wash et al., 1992; Byrd, DeSouza, Fingerhut, & Murphy, 1994). This technology has basically taken two forms. Many of the large universities that offer an academic major program in meteorology use the Unidata system, a University Corporation for Atmospheric Research (UCAR) program funded by the National Science Foundation. This system basically takes meteorological data provided through the Internet and processes that information using one of several software packages. The software then allows for different types of interactive meteorological data analyses using micro-computers. Examples of the software packages include the McIdas system developed at the University of Wisconsin and the WXP system developed at Purdue University (Wash, et al., 1992). Typically, these software packages would be used by students studying synoptic or mesoscale meteorology. For less advanced students in a survey course, different meteorological products can be looped into an animation display (Wash et al., 1992).

The second type of system in use is provided by one of several commercial vendors (Kavouras, Inc. provided the technology used in this study), and allows for a certain amount of interactive work. Its main strength, however, lies in the wide variety of raw analyzed data that are available. The data provided are more timely than that provided by the UNIDATA system, therefore this system meets the dual needs of the aviation student. That is, it not only serves as an aid to learning meteorology as an academic discipline, but can also serve as an effective flight planning tool. These systems are popular with the Federal Aviation Administration (FAA), and, as a result, have been placed in several collegiate aviation programs.

During the 1993 Unidata workshop meeting, a roundtable discussion group addressed the efficacy of the available technology in improving learning among students. Although the general feeling was that it did improve learning, no specific examples were given (Byrd et al., 1994). A large capital investment both on the part of the FAA and the recipient university is required, therefore it would seem appropriate to investigate the efficacy of the new technology in aiding the learning of meteorological concepts by aviation students and the value of these investments.

This study was comprised of three parts. Initially, a theoretical framework to help explain why this technology should be effective as a learning tool and how best to use it was explored. Secondly, suitable predictors for a student's success in an aviation meteorology course were determined. That was a necessary step so that the study's outcome could be controlled for the influence of extraneous variables. Lastly, the predictors were used in a limited, controlled, causal-comparative study in order to quantify any effects this new technology may have on success in learning meteorology.

The Role of Prior Knowledge

In the early 1960s, the educational researcher, Ausubel (1960), began exploring the role of prior knowledge. The theory that prior knowledge can influence learning can be traced at least as far back as the turn of the century and the philosopher Herbart, but it is with the work of Ausubel that research into this area really began (Barnes & Clawson, 1975). Ausubel used the terms "advance organizer" and "assimilation theory" to help explain his ideas. In an experiment described in 1960, Ausubel saw strong evidence that a written advance organizer containing general and abstract ideas influenced learning of a subsequent passage better than a historical overview of similar length (Ausubel, 1960). As quoted in Mayer (1979), advance organizers are "appropriately relevant and inclusive introductory materials...introduced in advance of learning...and presented at a higher level of abstraction, generality and inclusiveness." Ausubel talks of the "ideational anchorage" provided by ideas already present in a student's cognitive structure (Ausubel, 1980). Assimilation theory involves the idea of new knowledge being related to existing ideas already present. The new knowledge is then more readily understood. Lawton and Wanska (1977) elaborated: "Existing cognitive structure is the most crucial factor influencing new learning."

Although the advance organizers described by Ausubel (1960), Mayer (1979) and Lawton and Wanska (1977) were generally written organizers, Lawton and Wanska mention visual and audio organizers as well. Kenny (1993), in discussing computer based instruction, also talks of graphic organizers and pictorial graphic organizers.

The concept of an advance organizer is not, however, without its critics. Anderson, Spiro, and Anderson (1978), for example, felt Ausubel conducted his experiments when the concept of cognitive structures in terms of schemata was still in its developing stage. Their critique continued: "... when the reader does not possess relevant schemata, there is no reason to suppose they can be acquired from a few abstractedly worded sentences." (p. 439). In a response to his critics, Ausubel defended his ideas, and explained why organizers are dependent upon the material and that their specific structure varies (Ausubel, 1978).

The idea of advance organizers seems to be appropriate for use in a basic meteorology course where advanced ideas such as frontal systems and air masses can be presented early using technology in a general and abstract way, before their detailed discussion in the classroom. It is thought these advance organizers will help develop relevant schemata (or cognitive structures) in the students for the detailed concepts that follow. Mayer (1979) feels advance organizers work best with technical and unfamiliar ideas, therefore, this would appear to be an ideal situation for their use.

Statistical Matching on Extraneous Variables

Before the effectiveness of an instructional method can be assessed, and where random assignment of subjects is not practical, the problem of controlling for extraneous variables must be addressed. In a causal-comparative study such as this, statistical matching on these extraneous variables is a recommended way to control for their influence (Fraenkel & Wallen, 1993). Initially for this study, Scholastic Apptitude Test (SAT) scores, Grade Point Averages (GPAs), and high school class standings were considered the variables on which to match subjects in the control and treatment groups.

Recently, several studies have attempted to show that SAT scores add very little to predicting the subsequent performance of college students. A study by Baron and Norman (1992) looked at total SAT scores, high school class rank, and College Board achievement tests scores as predictors of college cumulative grade point averages. The study looked at freshmen who entered the University of Pennsylvania in 1983 and 1984. When the SAT scores were entered as a single zero-order variable, they accounted for only .04 of the total variance. When entered last in a hierarchical regression with achievement test scores and class standing, they contributed nothing to the total variance. Examination of the quadratic term did not change the results.

In recent years, the SAT's ability to predict college performance has apparently decreased. A study by Morgan (1989) reviewed 778 validity studies from 222 colleges accomplished from 1976 to 1985. Correlation of SAT scores with first year grades gradually decreased from .51 to .47 over this period (Morgan, 1989). Investigation as to whether this was caused by a change in the SATs that took place in 1985 was completed by Stricker (1991). By correlating the 1975 and 1985 SATs to class rank and high school GPA, he concluded that the 1985 SATs were no less valid than their 1975 predecessors. While Stricker sees the correlation of SAT scores with high school GPA and class standing as confirming the SATs' validity, Crouse and Truesheim (1991) see this as a redundancy. Because of this, they feel very few admissions decisions are changed because of SAT scores, and that the benefits of the SATs are small to non-existent. On the other hand, a study conducted at California State University (Hayward) found that SAT scores added a small but significant increase in ability to predict freshmen year GPAs (Cowen & Fiori, 1991). Kanoy, Wester, and Latta (1989) concluded that SATs and GPA were good predictors for high level students, explaining more than 50 percent of the variance when predicted GPA was 2.9 or higher but did not work well for students with low potential. Overall, these studies come to mixed conclusions as to whether the SATs have an additive effect in predicting college success as determined by GPA. Despite this controversy, there appears to be enough evidence that SAT scores should at least be considered as matching extraneous variables in a specific college course.

Methods

In the aviation program of one university, and probably many others, aviation meteorology is a required course for all entering students. It is usually completed during the first semester of the first year. The students enrolled in this course during the Fall 1993 semester provided a control group and a source to statistically match subjects. Well into this semester, the new technology, produced by Kavouras, Inc., was installed, and was comprised of a METPAC system which provides hard copy graphical and alpha-numberic data as well as a TRIMETS system which displays looped graphical, radar, and satellite data. Installation was partially funded by an FAA Airway Science grant. Although some use of the new systems was made during the latter half of the semester, initial startup problems and time constraints proved inadequate to implement their routine and systematic use. By the spring semester of 1995, a systematic approach to the use of the new systems was in place and appeared to be working well. The first eight weeks of the course, which included the period during which the control group had no access to the new systems, in contrast to the experimental group, was the main focus of the study.

Control Group Population and Subjects

During Fall 1993, four sections of aviation meteorology were offered with a total student number of 68. Twenty-two of these students were enrolled in a section taught by an adjunct instructor. Those students were excluded from the current study because of lack of standardization of both teaching and testing methods between instructors. The remaining three sections were taught by the same instructor and included 46 students. Of those 46 students, 11 were excluded from this study because their SAT scores and high school GPAs were not available for various reasons. Transfer students, for example, typically did not have this information in their files. This reason accounted for 9 cases. In two other cases, the data were simply not present in the students' files. One student was excluded because his 200 score on the verbal portion of the SAT indicated his English skills were probably inadequate. This was reflected in a 42 average computed without the benefit of a final examination which he did not complete. Total subjects remaining as a control for this study were 34. All were native English speakers, and 7 were female. Of these 34, 3 had no high school class standing reported, but it was a relatively simple matter to account for this missing data using substitution of the mean.

Experimental Subjects

The subjects were five students enrolled in aviation meteorology in Spring, 1995. Because most students take this course in the fall semester, only 13 were enrolled in the Spring, 1995 course. Further, since many of these students were transfer students, SATs and high school GPAs were available for only six students. Additionally, one of these students became ill for the two weeks prior to the mid-term examination missing the lecture and class discussion of important material. All experimental subjects were male and native English speakers.

Instruments

The study was based on midterm examination results. The midterm was a 40 question instrument covering the same material for both the control and experimental groups. Thirty-one of the questions used in the experimental group's midterm were similar to, or variants of, the questions used in Fall, 1993. For the purpose of this study, only those 31 questions were graded. The instruments used in this study were group administered, criterion referenced, in-class examinations. The questions were instructor developed with some help from textbook support material. Types of questions comprising the total score and their portion of the total score were about 75% multiple choice, 15% fill in type questions (one or two words), as well as about 10% which required short sentences for answers.

Procedures

The instrument was administered during the eighth week of the course. Each week prior to that time, a 25 minute laboratory period was used in addition to normal classroom time. The control group for which the predictors were based had no use of the new technology for the same time period during their semester. During this extra 25 minute period, a meteorological presentation of current conditions was made. Concepts such as fronts, air masses and upper level analyses were introduced four to six weeks before they were discussed in some detail in the lecture. Students understood that the material presented during this laboratory session was not to be tested, but that it might benefit them sometime in the future. The midterm was group administered by section. Fifty minutes were allowed for the midterm. Time appeared adequate with all students completing the instrument. The same room was used for administering all instruments.

Data Analysis

As a preliminary step to evaluate matching variables, multiple linear and curvilinear regression techniques were used to analyze the relation of the independent variables (Verb - verbal SAT scores, Math - math SAT scores, GPA - high school GPA, and CS - class standing) to an overall dependent variable, final grade, overall average in aviation meteorology. This was a comprehensive evaluation of the variables as predictors before they were applied more specifically to the mid-term grade only. This was done to ensure adequate testing of the selected matching variables. The initial analysis considered all components of an overall grade for the control group. Four instruments determined this grade. The mid-term was valued at 30% of the final grade and was comprised of 40 questions while the first and third instruments were each valued at 15. The final examination (representing 40 percent of the final grade) had 78 questions. It was these same techniques that were then repeated for the mid-term examination only, where the dependent variable was strictly the grade received on the mid-term exam.

Results

Descriptive Statistics

Table 1 depicts selected descriptive statistics for all linear variables where overall final grade is the dependent variable. Class standing (CS) is expressed in terms of the upper fraction of a student's high school class. For example, if a student were 10th out of a class of 100, the student's CS value would be .10. Sample size was 34. Table 2 describes the correlations between variables.

Table 1
Descriptive Statistics

	Mean	S.D.	Range
Verb	480.588	77.575	340.000
Math	554.118	74.635	370.000
GPA	3.301	.380	1.680
CS	.235	.160	.660
Grade	76.897	7.870	30.350

Table 2
Pearson r correlations between linear variables

	Verb	Math	GPA	CS	Grade
Verb	1.000				
Math	.302	1.000			
GPA	-.049	.092	1.000		
CS	-.161	-.088	-.673	1.000	
Grade	.475	.534	.423	-.330	1.000

The low correlations between SAT scores and high school GPA and class standing are interesting. The values for this sample are considerably lower than those reported by Stricker (1991), which ranged from .39 to .54. The current sample also indicates little redundancy between SAT scores and either GPA or CS. This is in contrast to the conclusions drawn by Baron and Norman (1992) in their study at the University of Pennsylvania.

Inferential Statistics

For this study alpha was set at .05 and power at .80. Initially, curvilinear effects for all four independent variables were calculated. The zero order linear terms of three of the four independent variables (all but CS) were significant at the preset alpha level. Neither the quadratic nor the cubic terms added significance to the independent variables. Therefore, a hierarchical regression was completed using only linear terms. To provide the required power, effect size for the hierarchical model was set quite high (f2 =.411, R2 = .29, R = .54 for four independent variables and f2 = .393, R2 = .26, R = .51 for 3 independent variables - calculations made in accordance with Cohen & Cohen, 1983). Math and verbal SAT scores were entered as a set, followed by High School GPA. Finally CS was added to the computation. Power exceeded .80 in all cases. (See Table 3). It was determined that the overall best regression fit was the hierarchical using three independent variables (Math, Verb, GPA). The addition of CS added little to R2, and increased the overall effect size required. A regression summary is included in Table 3. The resulting predictive equation for the final course grade was: Grade = 8.226 + .039 Verb + .040 Math + 8.427 GPA.

Table 3
Regression Summary

Variable	DF	Cumulative R2
SAT (Verb & Math)	2,31	.394*
GPA	3,30	.557**
CS	4,29	.570**

* $p < .001$
** $p < .0001$

In preparation for the pilot study, a regression analysis using only the midterm examination grade was made for the same subjects under the same conditions and using identical independent variables. Results were similar to when the overall (final) grade was the dependent variable and are shown in Table 4. The equation developed was:
Midterm Grade = 2.538 + .043 Verb + .047 Math + 7.351 GPA.

Table 4
Regression Summary

Variable	df	Cumulative R2
SAT (Verb & Math)	2, 31	.308*
GPA	3, 30	.420**

* $p < .01$
** $p < .001$

Results of the Pilot Study

The results for individual students follow in Table 5. Standard deviation for the instrument was 10.2. Interestingly, while student A received a grade nearly one half a standard deviation lower than expected, students C, D, and E all exceeded their predicted grade by more than one standard deviation.

Table 5
Student Performance

Student	Predicted Grade	Actual Grade
A	88.6	82.3
B	78.3	79.0
C	76.6	90.0
D	67.0	77.4
E	58.5	69.3

Conclusions

SATs were shown to be good matching variables for the sample of the 34 students that comprised the control group in this study. Additionally the linear regression of SAT scores combined with high school GPA showed significance as well as considerable power for predicting success in a basic aviation meteorology course (Table 3), and therefore were good extraneous variables upon which to match the subjects. When the computations were repeated for just the midterm exam, similar significance was demonstrated. For this particular experimental group, it does appear that technology may have made a positive difference.

Limitations

The five students in the experimental group of this causal-comparative study comprised an extremely small group, and it is apparent that no inferences can therefore be made. Moreover, this study, where the experimental group received a treatment more than a year after data were collected from the control group would tend to be prone to external validity threats including history and possible unintentioned experimenter bias.

Recommendations For Future Research

Despite the study's limitations, the fact that three of the five students in the experimental group showed an improvement of over one standard deviation over what was expected, coupled with the fact that there seems to be a need for some definitive research in this area as implied in the meteorological literature (Byrd et al., 1994) indicate a larger, more comprehensive experimental or quasi-experimental study should be completed.

Additionally, this study only addressed the efficacy of meteorological work stations as a specific type of learning tool, an advance organizer. Recommended additional areas of research would be to evaluate these work stations from other educational perspectives and also as flight planning tools.

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