Journal of Aviation/Aerospace Education & Research

Volume 4
Number 3 *JAAER Spring 1994*

Article 1

Spring 1994

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Scholarly Commons Citation
Moore, P. J., Telfer, R. A., & Smith, M. W. (1994). A Comparative Analysis of Airline Pilots' Approaches to Learning. *Journal of Aviation/Aerospace Education & Research, 4*(3). https://doi.org/10.15394/jaaer.1994.1127

A COMPARATIVE ANALYSIS OF AIRLINE PILOTS' APPROACHES TO LEARNING

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This paper reports a study investigating approaches to learning (deep, surface, achieving) by airline pilots. Three hundred and forty-six respondents from five international airlines and an institute completed the Pilot Learning Process Questionnaire (PLPQ). The results showed a general tendency for surface scores to be substantially lower than deep and achieving scores, with greatest variability among the carriers on the achieving scale. The European carrier was implicated in all post hoc analyses conducted and one Pacific Rim carrier's profile showed significant differences from other airlines. The results are discussed in terms of cultural, training/rewards, and tenure factors. Implications for pilot training and selection are noted.

Over the last decade researchers have identified three predominant approaches to learning by individuals: deep, surface, and achieving (Biggs, 1987a, 1987b; Entwistle & Waterson, 1988; Watkins & Hattie, 1990). The deep approach to learning is intrinsically motivated, with a desire for competence through deep understanding. Such learners read and discuss widely to integrate new information with their existing knowledge base. Surface-oriented learners, however, have a contrasting motivation. They seek to do the minimal amount to pass the subject. Surface-oriented strategies include rote learning and reproduction of material provided in course notes or manuals. The third approach, achieving, is a competitive strategy concerned with ego enhancement and organizing the time, source, and place of learning. The intent is to do well, but in order to do better than others.

How do these approaches affect learning outcomes? Research with high school and university students shows that a surface approach tends to be appropriate for recalling unrelated details (Biggs, 1979) but usually has been found negatively related to academic performance (Cantwell & Moore, 1990; Ramsden & Entwistle, 1981) and neutral to perceptions of academic performance (Watkins & Hattie, 1990). The deep approach leads to structurally complex responses, usually higher grades (Biggs, 1989; Ramsden & Entwistle, 1981; Watkins & Hattie, 1981) and higher self-estimates of achievement (Watkins & Hattie, 1990). The achieving approach also relates positively to academic performance and perceptions of performance (Watkins & Hattie, 1981, 1990).

Although this body of research informs the field about profiles (Biggs, 1987a, 1987b), remediation (Biggs & Rihn, 1984; Edwards, 1986; Moore, 1991a) and longer-term effects of school-type learning (Ainley & Sheret, 1992; Biggs, 1987a), the application to aviation is unclear. Indeed, between typical school learning and commercial aviation instruction there are several differences that indicate the need for caution in applying the results of instructional research from other contexts.

For example, Telfer (1993) identifies several factors that differentiate school and aviation learning: the structure, mission, focus, flexibility, budget, and teacher. While schooling places emphasis on effectiveness (that is, achieving the instructional goal), because of the expense involved the emphasis in aviation is on efficiency, the cost of competency. The final difference Telfer (1993) identifies is the aviation instructor, who lacks the permanent career structure, and the amount of initial preparation provided those in general education contexts.

In sum, learning in aviation differs from learning in school, college, or university. Perhaps the major differences, at least at the individual learning level, are those related to the nature of the material to be learned, the types of examinations (typically multiple-choice questions), and the critical application of the knowledge, skills, and values to operations. Additionally, evidence

suggests that flying instructors tend to encourage rote learning, imitation, and rehearsal (as low-level, non-integrative strategies) as the main ways in which learning should be undertaken (Henley, 1991). Overriding all this is the pressure of the cost of learning to fly or gaining endorsements on different types of aircraft. Failures, overflies, and remediation are costly in many ways for individuals and companies.

How do such differences affect approaches to learning? Is a surface approach of benefit in learning certain types of information? Do the general patterns seen in school studies hold true in aviation?

The relationships between approaches to learning and performance in aviation have been examined in several different populations as part of the ongoing Approaches to Pilot Learning Project at the University of Newcastle. The first study, by Moore and Telfer (1990), examined approaches to learning (and their relationships with learning outcomes) in a sample of pilots training to gain a commercial pilot license (ab initio pilots). Sixty-two pilots completed a slightly modified approaches-to-learning questionnaire developed by Biggs (1987b), the Study Processes Questionnaire (SPQ), and their scores on the surface, deep, and achieving scales were correlated with performance in ground-school topics (rated for degree of difficulty) and hours to solo. Highly acceptable reliabilities have been reported for the SPQ in school-type contexts (Biggs, 1987b) and the results showed acceptable levels of reliability for the scales (alpha-coefficient 0.65 for surface approach, 0.76 for deep approach, and 0.79 for achieving approach) and a consistently significant negative relationship between ground-school scores (total, easy, moderate, difficult) and the surface approach measure. This pattern is consistent with school-type studies (Ramsden & Entwistle, 1981). In addition, those pilots adopting a deep approach to learning soloed earlier.

The second study (Moore, 1991b) gained data from a sample of 30 experienced pilots undertaking retraining. All were being trained by an international carrier to fly wide-bodied jets (Moore, 1991b). As in the previous study, the subjects were given the modified SPQ (Biggs, 1987b) to ascertain surface, deep, and achieving scores. These were related to performance in three ground-school topics: initial test, type test, and safety test. In addition to ground-school scores, a rating was gained for performance in a final simulator check ride. Co-efficient alphas of 0.30 for surface, 0.58 for deep, and 0.82 for achieving showed that sections of the scales were not acceptable, particularly the surface scale. The correlations showed very little relationship between approach scores and performance in ground school or in the simulator.

In the third study (Telfer, 1991), experienced commercial jet pilots (n=11) were interviewed about their learning. Interviews were structured but open-ended to explore the following: personal organization to meet requirements of periodic tests and checks; preparing for and predicting test performance; scheduling learning around work rosters; strategies for learning new information; differences in strategies for learning different information and skills; changes in learning approaches since ab initio training; views on instructional design of pilot training (Telfer, 1991). The findings demonstrated that experienced pilots use a range of strategies and motives for the specific learning they need to do in aviation. Clearly, some of these approaches are deep in orientation (desire to understand, reading widely, self-testing levels of learning, using own summaries), others are surface (learning emergency drills), and others achieving in orientation (setting priorities, using timetables for study, having material in compact form for studying). Given the unreliability of Biggs' (1987b) SPQ scales for experienced pilots and the interview study's findings that experienced pilots do use different approaches to learning, a fourth study was undertaken to develop a set of reliable and valid scales for assessing approaches to learning in experienced pilots. That study (Telfer & Moore, 1993a) used a sample of 335 experienced commercial pilots flying for five international/national carriers. Factor analyses revealed three factors (surface, deep, achieving) with reasonably satisfactory reliability co-efficients of 0.70, 0.58, and 0.73 respectively. The result was a three-scale, 30-item instrument: the PLPQ. Details of the instrument's validity, in factorial terms, can be found in Moore, Smith, and Telfer (1994). With the development of an appropriate instrument for assessing experienced pilots' approaches to learning, this study sought to examine any

DOI: https://doi.org/10.15394/jaaer.1994.1127

Table 1
Means and Standard Deviations for Age, Hours, and Surface, Deep, and Achieving Scales*

Airline	Age	Hours	Surface	Deep	Achieving
Pacific Rim # 1 (n=22)	39 (7)	5878 (4036)	2.81 (.44)	4.73 (.42)	4.13 (.54)
Pacific Rim #2 (n=55)	41 (6)	10046 (3608)	2.93 (.55)	4.65 (.51)	4.15 (.59)
Pacific Rim #3 (n=94)	41 (7)	8751 (3342)	2.91 (.57)	4.45 (.43)	3.95 (.54)
Pacific Rim #4 (n=41)	42 (10)	10456 (7006)	2.59 (.51)	4.80 (.38)	4.35 (.49)
European (n=122)	42 (8)	7414 (3939)	2.57 (.55)	4.70 (.45)	3.64 (.61)
U.S. Institute (n=12)	40 (13)	6233 (6511)	2.69 (.46)	4.55 (.48)	3.96 (.43)

* Standard deviations in parentheses

differences in approaches to learning that might exist among pilots operating in different airlines. The approaches-to-learning literature for institutional learning certainly shows institutional effects on approaches to learning (Biggs, 1987b; Ramsden & Entwistle, 1981) and that different cultures may vary in the emphases they place on particular approaches to learning (Biggs, 1990; Hattie & Watkins, 1981). In a similar manner, Hofstede (1991) points to cultural differences in the ways individuals negotiate with each other. He identified dimensions of power-distance, uncertainty-avoidance, individualism, and masculinity. The question here, though, is whether there are differences in airline profiles with respect to surface, deep, and achieving approaches to learning.

There are reasonable grounds to argue, at least from the school/university data, for differences from a cultural perspective that could be reflected in airline policy and training. For instance, do pilots flying for European airlines differ from those flying for Asian and South Pacific carriers? On the other hand, it could be argued that potential cultural effects could be suppressed by the nature of the training done by the experienced pilot. Much of the training material used in the industry for endorsement training is produced by the major aircraft manufacturers in a standard form and most airlines use the materials in the same way. In a similar way, there is reasonable consistency in what is required of a pilot for licensing and operational purposes and this may also influence any potential differences in approaches to learning. There is also the potential influence of tenure and opportunity for promotion within an airline. If pilots are on contract bases with renewals dependent on performance, such pressures may affect the ways pilots approach learning.

In summary, this study sought to explore similarities and differences among experienced pilots' approaches to learning depending on their airline.

METHOD

Subjects

The sample comprised 346 experienced pilots. All flew as either commercial or airline transport pilots and were associated with four Pacific Rim carriers, a European carrier, and an aviation institute in the United States. These affiliations were indicated by the following terms: Pacific Rim #1 (22 pilots); Pacific Rim #2 (55 pilots); Pacific Rim #3 (94 pilots); Pacific Rim #4 (41 pilots); European (122 pilots); U.S. institute (12 pilots).

Ninety-two percent of the sample (312 cases) had a commercial aviation involvement; the remaining 8%

(n=28) were drawn from general aviation. All participants held an ATP.

Details of the sample are provided in **Table 1**, showing means and standard deviations of the total flying hours and age of the participants from each group. Means and standard deviations have been rounded off to the nearest whole number.

Mean total flying hours varied from a low of 5,878 (Pacific Rim #1) to a high of 10,456 (Pacific Rim #4). Standard deviations tended to be high (with a maximum of 7,006 in Pacific Rim #4), indicating a relatively wide range of flying experience within the aviation sub-group of ATP qualified pilots. The ages of the respondents tended to be more homogeneous, with a standard deviation of eight years across the sample.

Materials

The 30-item PLPQ developed by the researchers (see validity and reliability data above) was used. Pilot responses to each of the 30 statements were indicated on a six-point Likert scale ranging from Strongly Disagree (a score of 1) to Strongly Agree (a score of 6). The instrument has three sub-scales (surface, deep, achieving), each with 10 items. An example from each of the sub-scales is provided below:

Surface: "As a pilot, my job is to operate the aircraft, not understand it."

Deep: "Understanding of concepts and theories in aviation provides a challenge for me."

Achieving: "I have a fair idea of what others are doing, so that I know how much extra I have to do to top them."

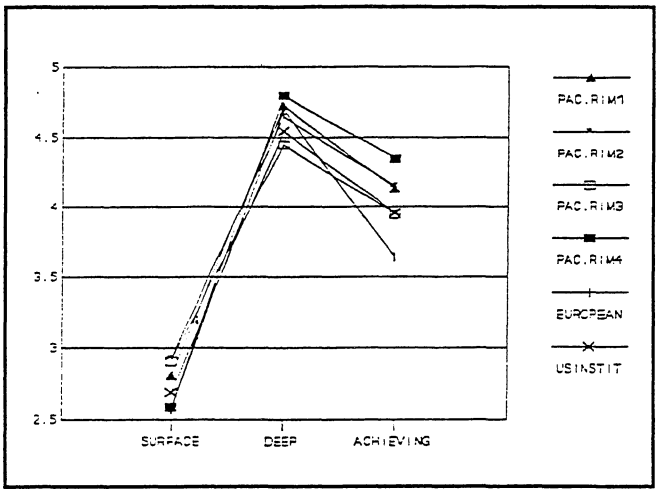
Procedure

The PLPQ instrument was distributed to pilots through company operations. The answer sheets were returned to the company for transfer to the researchers. Pilots were not required to include their name on the answer sheet.

RESULTS

The data were analyzed using a series of Group (Pacific Rim airlines 1, 2, 3, 4, European airline, U.S. institute) ANOVA on the dependent measures of surface, deep, and achieving scores from the PLPQ. Where significant effects were indicated, Scheffe post hoc analyses were conducted to determine the major sources of the differences. The respective means and standard deviations are presented in Table 1 and the means are presented, to show carrier profiles, in **Figure 1.**

Figure 1
Surface, Deep and Achieving Scales



For surface scores, a significant Group effect was found, $F(5,340) = 6.47$, $p < .000$. Follow-up Scheffe tests showed European scoring significantly lower on surface scores than Pacific Rim #2 and Pacific Rim #3. For deep scores, a similar significant Group effect was found, $F(5,340) = 5.26$, $p < .0001$, with post hoc analyses showing significant differences between several airlines. In this case, Pacific Rim #3 scored significantly lower than both European and Pacific Rim #4. For the achieving sub-scale scores, there was a significant Group effect, $F(5,340) = 13.46$, $p < .0001$, with Scheffe analyses showing European scoring significantly lower than the four Pacific Rims (#1, #2, #3, #4) and Pacific Rim #3 scoring significantly lower than Pacific Rim #4, the airline with the highest score on the achieving scale.

Also apparent in the data are the differences between the sub-scale scores with the overall surface mean being 2.74, substantially lower than the overall means for deep (4.63) and achieving (3.93).

DISCUSSION

This research sought to investigate potential differences in experienced pilots' approaches to learning. Three prototypical approaches were examined—surface,

https://commons.erau.edu/jaaer/vol4/iss3/1
DOI: https://doi.org/10.15394/jaaer.1994.1127

deep, and achieving—through the application of the PLPQ.

What is evident from the data is that there are only minor systematic differences among the airlines used in this project. Despite the differences in total flying hours of the pilots who constituted the sample, which had an overall standard deviation of more than 4,000 hours in an overall mean flying experience of some 8,000 hours, the trends were similar. The greatest range of scores (indeed, almost twice the range of the surface and deep scales), and statistically significant differences was in the achieving scale with European scoring significantly lower than all Pacific Rim carriers. The highest mean score was gained by Pacific Rim #4. Indeed, in all significant post hoc analyses, European was represented. European had the lowest surface score, significantly different from two Pacific Rims (#2 and #3) and the differences in the deep scores showed European and Pacific Rim #4 scoring higher than Pacific Rim #3. So European contributed in a nontrivial manner to the reported differences. In a similar way, Pacific Rim #3 emerged in two of the comparisons with the highest scores on the surface scale and the lowest scores on the deep scale.

To what might these differences be attributable? In the absence of further data this discussion cannot be definitive, but some possibilities emerge. Major variables appear to be the selection, training, and career structure of pilots. The quality and relative homogeneity of pilot intake to an airline would be a determinant in the learning approach adopted by individuals. Similarly, the subsequent instructional and training methods adopted within the company would have a capacity to shape the individuals' approaches to learning. Finally, the stability of tenure of relative mobility of pilots across employers would affect the extent to which such approaches could become characteristic. These issues are discussed further in Moore (1994).

In more general terms, the results showed a similar pattern for each airline. This profile followed lowest scores on the surface scale, achieving scale next highest, and the highest scores on the deep scale. Thus, this population of pilots had a propensity for approaching their learning in a meaningful, strategically driven manner. The relatively lower scores for surface suggests that minimal level interactions with material to be learned were not a major way in which these pilots learned. Indeed, when compared to interview studies of experienced pilot learning (Telfer & Moore, 1993b), the finding of such low scores is not surprising. Telfer and Moore (1993b) showed that experienced pilots did see a role for surface-type strategies (in this instance, rote learning), but the application of such strategies was consistent with a high-level, metacognitive understanding of the reasons for employing such strategies. The relatively high achieving scores also show that this population was competitive and organized, a finding seen in other pilot studies (Moore, 1991b; Telfer and Moore, 1993b).

Given the increasing role of automation in the cockpit, a trend toward long-haul flights, and the effect of standard operating procedures in producing predictable and routine pilot involvement in cockpit activities, there is value in pursuing the implication of a potential conflict between a deep propensity for learning with the imposed limits to predominantly surface operations. Obviously, opportunities exist for deep involvement, but these are exceptional because of the safety ensured by standardized and automated operations. One solution here is the opportunities afforded by line-oriented flight training for thoughtful responses, in both a human and technical sense, to testing situations that force air crew to extend their personal performance envelopes. Such ingenuity may need to be extended elsewhere in the check-and-training context.

Several limitations impinge on any conclusions. The study was limited to basically five international carriers with a total sample of more than 300 pilots. Only one European airline provided data, so there was no range of comparisons in that context. The Pacific Rim airlines, although providing some degree of variation, may have benefited from the inclusion of other Asian carriers to allow a more thorough investigation of potential cultural effects. A final limitation is that this study only described the profiles of the airlines and compared them. The question of the relationships between the experienced pilot's approach to learning and the quality and quantity of learning as measured by examination results, simulator

performance, and performance in the cockpit itself has not been addressed.

Although we have reported differences among airlines in terms of approaches to learning, these differences may or may not translate to differences in the operation of the aircraft. Further research is being conducted to examine the complex relationships among these variables. If it can be demonstrated that certain approaches are more effective than others in producing quality outcomes, this knowledge may provide guidelines to those involved in selection and training in airlines. Finally, in terms of overall operations, the issue of safety and its relationship to these learning scales is one that certainly requires investigation.□

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