# Approaches to Learning in a Vocational Context

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Running Head: Vocational Learning

Paper presented at the Joint Australian and New Zealand Association for
Research in Education Conference, Deakin University, Geelong, November, 1992.

## Abstract

This paper reports several studies investigating the relationships among
approaches to learning (Deep, Surface, Achieving) and performance in learning in a
vocational context. In one aviation study, trainee pilots constituted the sample. Results
showed negative relationships between a surface approach and learning of ground
school topics. Hours-to-solo was negatively related to deep approach scores. In
another study of experienced pilots, only the deep approach related

significantly to
learning outcomes. A third study reports interview data from experienced airline
transport pilots. A fourth study developing new approaches to learning scales for
experienced pilots is discussed.

## Introduction

Over the last decade researchers have been investigating the relationships
between the ways in which individuals approach their learning and academic
performance (e.g. Entwistle & Waterson, 1988; Marton, 1988; Watkins & Hattie, 1990).
Typical of this research is the work based upon Biggs' (1987a, 1987b) identification of
three predominant approaches to learning: Deep, Surface, and Achieving. The deep
approach to learning is typified by intrinsic motivation and the desire to be competent
in the area of study. To achieve deep understanding, learners read widely and
integrate their new knowledge with their existing knowledge base. On the other hand,
the surface oriented learner is motivated by anxiety and the desire to do the minimal
amount to pass the subject. Surface oriented strategies include rote learning and
reproduction strategies. The third approach, achieving, is concerned with ego
enhancement and organising both time and place of learning.

How do approaches to learning relate to learning outcomes? A surface approach
tends to be appropriate for recalling unrelated details (Biggs, 1979) but has generally
been found to be negatively related to academic performance (Cantwell & Moore, 1990;
Ramsden & Entwistle, 1981) and neutral to perceptions of academic performance
(Watkins & Hattie, 1990). On the other hand, the deep approach leads to structurally
complex responses and 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).

All of the above literature on approaches to learning has been gained from typical school-type settings: high schools, colleges and universities. While this body of research informs the field about profiles (e.g. Biggs, 1987a; 1987b), remediation (e.g. Biggs & Rihn, 1984; Edwards, 1986; Moore, 1991a) and longer term effects of school-type learning (e.g. Ainley & Sheret, 1992; Biggs, 1987a), it clearly ignores learning in other contexts, contexts that are concerned with the learning of "need-to-know" information in which learners are expected to learn, and then apply specific information to satisfy vocational requirements and high public expectations of safety. Indeed, in the context of the studies reported in this paper, there are non-trivial differences between typical school learning and commercial aviation instruction.

Telfer (in press) identifies several factors that differentiate school and aviation learning; structure, mission, focus, flexibility, budget, and the teacher. The structure of learning in aviation is more centralised than in schools and the mission in aviation is to provide knowledge and skills and recognised accountability for a particular activity (flying) as opposed to schools where the transmission of culture, the preparation of individuals to live in a society, is one of the major goals. The focus in aviation is on the transfer of learning compared to delayed performance (in tests at major stages of schooling) and there are far less options for those learning in aviation due to common examinations and government regulated licence requirements. There is a core of knowledge and skills that has to be mastered before a commercial licence will be granted by the authorities. In a similar way, there is a specific body ofknowledge/skills required for endorsement on particular aircraft (e.g. transferring from turbo-propeller aircraft to wide-bodied jet aircraft).

While schooling places emphasis on effectiveness (i.e. achieving the instructional goal), the emphasis in aviation is on efficiency, how much it costs to achieve the goal (a failure in flying may lead to extra hours of instruction in the

aeroplane which obviously costs money). The final difference Telfer (in press) identifies is the teacher. In schools the teacher is specifically trained over a period of three to four years, has a code of ethics and has usually taken on teaching as a career. By way of contrast, instructors in aviation tend to be transient (using their instructor time in the aircraft to build-up their flying hours) and have limited training (50 hours).

In sum then, learning in aviation is different from learning in school-type settings. Perhaps the major differences, at least at the individual learning level, are those related to the nature of the material to be learned, the nature of the examinations (typically multiple choice questions), and of course, the application of the knowledge by actually flying the aircraft. Hand in hand with this is the finding 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 of this is the pressure of the costs of learning to fly or gaining endorsements on different types of aircraft. Flying is expensive and failures to learn may lead to additional costs which have to be borne by individuals or companies.

In such a pressure driven vocation then, the issue of approaches to learning arises. Is a surface approach of benefit in learning certain types of information? Do the general patterns seen in school studies of negative effects of surface, and generally beneficial effects of deep on learning hold true in aviation? It is worth reminding readers that the aviation industry utilises mnemonics extensively, especially in aircraft operating procedures, a strategy that does not necessarily encourage deep learning.

In this paper, the relationships between approaches to learning and performance in aviation are examined in several different populations. All are part of the ongoing Approaches to Pilot Learning Project at the University of Newcastle. The

first study examines approaches to learning (and their relationships with learning outcomes) in a sample of pilots who were training to gain their commercial pilots licence (ab initio pilots). The second reports data from a sample of experienced pilots who were undertaking retraining to fly new wide-bodied commercial jet aircraft (Pilots Undergoing Initial Training - PUIT), while the third study reports interviews with a small sample of experienced commercial jet pilots. The concluding study examines ways in which approaches to learning in experienced pilots might be more appropriately assessed.

The Ab Initio Study

This study used 62 ab initio pilots for its sample. The methodology and results are more fully described in Moore and Telfer (1990). All were administered the Study Processes Questionnaire - SPQ (Biggs, 1987b) which had been slightly modified to accommodate aviation terminology (e.g. "instructor" augmented "lecturer", "briefing" to augment "lecture"). The SPQ yields three approach scores: Surface, Deep, and Achieving. Data were gathered also on individual performance in each of the nine ground school topics (e.g. Aerodynamics, Navigation, Flight Planning) and the time it took them to fly solo.

Before correlational analyses were undertaken, it was decided to group the ground school topics in order of difficulty-to-learn as rated by instructors. In this way, the relationships between approaches to learning and performance of subjects rated as"easy", "moderate", and "difficult" to learn could be examined. For details on the rating procedure see Moore and Telfer (1990). The alpha-coefficient reliability of the scales were calculated at 0.65 for Surface Approach, 0.76 for Deep Approach, and 0.79 for Achieving Approach.

The results of the correlational analyses are shown in Table 1. For the ground school results, the most prominent finding is the consistently significant negative relationship between ground school scores (total, easy, moderate, difficult) and the surface approach measure. Ab initio pilots who reported adopting a surface approach

to learning scored lower on all measures of ground school learning than those who adopted a less surface oriented approach. This pattern is consistent with school-type studies (e.g. Ramsden & Entwistle, 1981). On the other hand, while the relationships between Deep scores and ground school scores are all positive, they do not achieve significance. Achieving scores, either in isolation or in combination with Deep scores, did not prove to be significant but the addition of Achieving to Surface tended to neutralise the negative effects of Surface.

The finding of a significant negative relationship between Deep scores and hours-to-solo indicates that those pilots adopting a deep approach to learning were those who took to the air on their own earlier than those who did not report such an approach to learning.

Briefly, then, the findings from the ab initio study demonstrate some consistency with school-type studies: a generally negative effect of a surface approach to learning, and a tendency for positive effects of a deep approach. The finding that deep and hours-to-solo were significantly related provides a new perspective on the role of approaches to learning in a vocational context.

Table 1: Correlations between Approach and Performance Scores
(Ab initio pilots)

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Surface
Approach

Deep
Approach

Achieving
Approach

Deep
Achieving
Approach

Surface
Achieving
Approach

Total
Ground
School
(N=62)

-0.28**

0.19

0.09

0.16

-0.11Ground

School
Easy
Topics
(N=62)

-0.26*

0.14

0.15

0.16

-0.05
Ground
School
Moderate
(N-62)

-0.29**

0.16

0.00

0.09

-0.17
Ground
School
Difficult
(N=62)

-0.21*

0.19

0.08

0.15

-0.07

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* p<.05
** p<.01

The Pilot Under Initial Training (PUIT) Study

Thirty experienced pilots formed the sample. All were experienced in flying multi-engined turbo-propeller aircraft and were being trained by an international carrier to fly wide-bodied, multi-engined commercial jet aircraft (e.g. Boeing 747, Boeing 767). The study is presented in detail in Moore (1991b).

As in the ab initio study, the subjects were administered the SPQ (Biggs, 1987b), again with minor modifications, to ascertain Surface, Deep, and Achieving scores. Data were gathered also on performance in three ground school topics: Initialtest, Type test, and Safety test. The Initial test assesses the PUIT's knowledge of aviation and flying on entry into the training programme. The Type test, an open-book examination of three hours, assesses knowledge (e.g. operations) of the particular aircraft for which the pilot is being trained. It follows an intensive coverage of the content of the aircraft manufacturer's training programme which is presented through an audio-visual system by which individual pilots pursue their learning. The Safety test examines knowledge of the safety procedures of the particular aircraft.

In addition to ground school scores, a rating was gained for the PUIT's performance in their final check ride in the fully operationalised flight simulator. Instructors rated the pilots from 1 (requires considerable training) to 8 (high standard).

The results of the correlational analyses are presented in Table 2. The alpha co-efficient reliabilities were calculated as 0.30 for Surface, 0.58 for Deep, and 0.82 for Achieving.

The correlations show very little relationship between approach scores and performance in ground school or in the simulator. The only significant relationship is between scores on the Type test and Deep scores. PUITs reporting a meaning-oriented, wide reading approach to learning scored higher on this test of the particulars and principles of the aircraft they were being trained to fly. In contrast to the ab initio results, surface scores are not negatively related to performance, and deep is not related positively to the measure of knowledge application, flying the simulator. It should be noted, however, that the reliability index for the Surface scale is only 0.30 for the PUIT sample.

Table 2: Correlations between Approach and Performance score
(Pilots Undergoing Initial Training - PUITs)

| | Approach |
|---|---|
| Pilot Initial Test | |
| Type Test | |
| Safety Test | |

Simulator Test
Surface

0.00

0.12

0.03

0.06Deep

0.08

0.30*

-0.08

-0.11Achieving

-0.09

-0.04

-0.10

-0.05_____
_____
* p <.05

In considering these above differences, several points need to be taken into account. Firstly, ab initio training is certainly "closer" to school-type learning than training for the PUITs. Ab initio training is conducted in classrooms similar to those in schools and the instructors tend to dominate the learning environment. For the PUIT, the major part of learning occurs through independent study conducted at study carrels which provide audio-visual input on the features of the particular aircraft. Secondly, the amount of experience in aviation, clearly differentiates the two populations. Many of the PUITs had thousands of hours flying a variety of aircraft

whereas the ab initio pilot is required to fly to 175 hours for the commercial licence.

The findings from this second study raised some questions about the reliability and validity of the SPQ for examining pilots who had substantial experience in the industry. Several of the PUITs had indicated in their responses that items from the SPQ seemed not to be relevant to the retraining or endorsement context in which they were learning, and, as already noted above, reliability co-efficients were quite low, especially for the Surface scale. To further ascertain how experienced pilots approach their learning, a third study was undertaken in which pilots were interviewed about the own approaches to learning.

The Interview Study

For this study a small sample (n=11) of commercial airline pilots was interviewed. They were captains or first officers flying wide-bodied jets for international of domestic carriers. The interview schedule was structured but open-ended and was designed to explore the particulars of the following: Personal organisation 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. A detailed description of the study is provided in Telfer (1991).

In terms of personal organisation, the pilots commonly used personal notes from manuals or briefings and reduced them to pocket sized notes that could be carried with them so that they could consult and self-test when they had spare time. One pilot used his wall calendar at home to mark of important test days (licence renewals, simulator check rides, aircraft check rides) and then organised his studying to fit that pattern. His major concern was with self-testing so he carried his summaries on

small cards
that he studied while staying overnight at the various destinations to which he flew.
Prioritisation was clearly a dominant feature of the experienced pilot's learning.

The pilots seemed well aware of their own strengths and weaknesses in
preparing for and predicting test performance. They discussed compensatory strategiessuch as studying more in areas where they perceived difficulties. They further reported
that they used mental rehearsal utilizing their kitchen tables, lounge chairs and
driving seat in their cars to simulate particular operational procedures such as
shutting down engines in an emergency.

Learning of new information was handled in different ways by the experienced
pilots. They recognised that some topics were easier to learn than others and that
adaptiveness is required. For the more difficult topics, procedures were learned,
rehearsed, in the cockpit of a parked aircraft, or by using, as noted above, non-aircraft
settings such as the car seat. One of the most senior pilots analysed new operations in
terms of the older operations by asking questions about why the new procedure was
introduced, how was it superior to the old version, was it safer etc. In learning
performance data for particular aircraft, strategies such as associating the data with
an event, relating them to a simulated flight or using them to compare aircraft types
in critical situations (e.g. diving speed) were reported.

Most respondents reported a change in their approach to learning, identifying
that their ab initio training as rote-learning oriented. They were critical of their own
learning styles, commenting, "Now I try to find the reasons; understand the rationale"
and "My ab initio was done in the old school setting of the military...learn by threat of
failure". Some, however, still employed rote learning for particular aspects such as
safety drills, but all indicated that they used less surface approaches to learning now
they were experienced pilots.

In commenting upon pilot training in general, several points emerged. The
quality of instructors and their selection and training was identified as

an area
requiring attention as was remediation within the system. Some thought there was an
inability in the system to identify precisely where instruction and training had broken

down, and further they saw a general lack of knowledge of what could be done if such
an eventuality did occur. On the positive side, they saw learning to be more co-
operative than competitive at this stage of their careers. Discussing learning with
other pilots, in non-working situations (e.g. at the bar), was seen as an important
mode for gaining understanding.

In summary, this interview study demonstrates 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 (e.g. desire to understand,
reading widely, self-testing levels of learning, using own summaries), others are
"surface" (e.g.learning emergency drills), and others "achieving" in orientation (e.g.
prioritising, using timetables for study, having material in compact form for studying).
With these data and the results of the two previous studies, a fourth study was
undertaken to develop an instrument for assessing experienced pilots' approaches to
learning which would be more "situated" than the SPQ (Biggs, 1987b).

The Questionnaire Development Study

This study is currently in progress. Its aim is to develop a reliable and valid
questionnaire that could be used to assess experienced pilots' approaches to learning.
Following the earlier work of Biggs (1987a; 1987b), the intention of the questionnaire
is to examine Surface Approaches (motives and strategies), Deep Approaches (motives
and strategies), and Achieving Approaches (motives and strategies) to learning in the
particular context of experienced pilot learning.

A sixty-two item, 6 point Likert scale, instrument was developed by modifying
several of the Biggs' items and adding additional items that arose from the interview
data. Other Biggs' items were deleted from the questionnaire as their

context was notrelated to the experienced pilot (e.g. I chose my present courses largely with a view to the job situation...).

A selection of the new items is shown below:

* I like to self-test myself to see how much I have learned.
* You can learn a lot by just asking your colleagues how they solve problems.
* As a pilot, my job is to operate the aircraft, not understand it.
* It is not necessary to get more than the manufacturer's viewpoint on a problem.
* When learning new performance figures, I relate them to those of other aircraft I have flown.
* I hate the thought of learning for tests and checks.
* I prefer to get the theory out of the way so I can get back to flying
* I listen to what we are told and try to reproduce only that in the test.
* I try to timetable my study around domestic commitments.
* It is not important to work beyond the information supplied by the company.

Experienced pilots from a number of international and national carriers are involved in completing the questionnaire and it is expected that something in the range of 300 responses will be gathered before the end of 1992. At that stage both factor analytic and reliability analyses will be undertaken which will lead to a new "situated" approaches to learning measure for use with experienced pilots. In follow-up investigations, the relationship between approaches and performance in ground school topics, simulators and check rides will be examined to ascertain if particular approaches are beneficial for specific areas of learning. Diagnostic and remediation strategies can then be introduced to increase pilot learning.

Concluding Comments

The series of studies outlined above have been concerned with the ways in which pilots go about learning in a context which, in some ways replicates school-type learning but in other ways differs quite substantially, especially for the experienced pilot. Vocational learning does differ from typical school learning. The

general pattern of findings for the ab initio pilots reflected previous school findings for surface approaches to learning in particular and the PUIT study showed a significant relationship between Deep scores and the important test of particulars and principles of the aircraft that they were learning to fly. Deep was related to flying performance in th ab initio situation, but not when it came to simulator checks for the experienced pilots. The interview study clearly identified the motives and strategies of the experienced pilot in the "situated" context of their learning. The results of the Questionnaire Development study should provide the aviation industry with a reliable and valid instrument which can be used to identify pilots' approaches to learning. A fifth study is being planned that will examine the relationships between experienced pilots' performance and their approaches to learning as measured by the new instrument. Such an instrument could be used diagnostically and armed with particular profiles, the industry could then provide remediation to those with inappropriate profiles. Such an instrument could also be employed in pilot selection.

Acknowledgments

The staff and trainees of the Civil Aviation Training Academy are thanked for their voluntary involvement in Study 1. For Study 2 we express our thanks to the QANTAS PUITs and the management of QANTAS. For Study 3, we thank those pilots who generously gave their time to be interviewed. The co-operation of the following airlines is acknowledged in Study 4: Air Nuigini, KLM, Swissair, Philippine Airlines, Cathay Pacific, Dragonair, Air New Zealand and ANSETT New Zealand.

The four studies have been supported by funds from the Research Management Committee of the University of Newcastle.

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