The Effects of Age, Sex and Education Level on Air Traffic Control Training Outcomes

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Applied Psychology

By

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Abstract

Two studies are reported which investigated the effect of individual demographics on training performance in air traffic controllers. The first study investigated the relationship between the demographics of age, sex and education level, and pass/fail rates at an air traffic control training centre. The data for this study was an historic data set provided by Airways Corporation, which oversees air traffic management in New Zealand. This includes training all controllers and providing all air traffic control in the country. The primary result of the first study was that trainees with post-secondary education achieved better during training than trainees with a high school education. Additionally, the level of education attained by the trainee appeared to be the best predictor (of the three demographic characteristics) for a trainee's success. The data was limited, due to a significant amount of incomplete trainee records. This impaired the ability to conclusively resolve the role of these demographic characteristics for trainee success. The second study, investigated the impact these same demographics may have on trainee success in a much smaller (N=16), but complete (i.e., no missing records) and current cohort. In addition, the feedback given and received in a training centre to the 16 trainees was examined. The trainees under consideration in this study were attending the Airways training centre. The trainees' debriefs after their air traffic control training sessions in Airways' immersive tower simulator were recorded. The trends in the data validate the need for further research. The primary result of the second study however, was that there was a significant difference in the pass rates of those trainees with only a high school education (66.7% failed) and those with post-secondary education (0% failed). The other two demographic characteristics of interest, age and sex, did not significantly differ for those trainees who passed and failed. The combined results of these studies indicate that the air-traffic control community in New Zealand may benefit from further investigating these differences and potentially raising education requirements for air traffic control trainees.

Chapter 1: Introduction

This research comprises two studies in which the effect of individual demographics age, sex, and education level on performance of air traffic controller (here after, controllers) trainees was investigated. The first study investigated the relationship between demographics of age, sex and education level and pass/fail rates at a training centre using an historic data set provided by Airways. This data had, however, a significant amount of missing records that may have obscured the results. In the second study the impact these demographics had on a complete and current cohort of Airways trainees in the training centre was explored. In addition, the feedback these trainees received was also examined to see if this further illuminated the role these demographic characteristics may have in trainee success. Considering the safety aspect attached to the job this research has significance for all air travellers. Controllers' primary concern is the safe and economic control of air traffic. Therefore, their training must produce competent controllers at a quick and efficient enough pace to fill international or national demands, which are high (French, 2009). The International Federation of Air Traffic Controllers estimates a shortage of at least 3,000 controllers worldwide (French, 2009).

1.1 Air Traffic Control

Controllers operate air traffic control (ATC) systems. Their job is to direct the safe and orderly movement of aircraft while flying, landing, taking off and taxiing (Career Services, 2009). Worldwide, ATC is considered one of the most difficult jobs, due to the high level of responsibility while on duty. ATC is notoriously stressful and complex, depending on a range of variables (Owen, 2009). It involves constantly changing conditions, time pressures, uncertainty and at times a sense of urgency (Owen, 2009). French (2009) describes it as 'taking thousands of people's lives into your hands every day, knowing a slip or lapse of

concentration can put them all at risk'. There is no space to pause in order to reflect and debrief (Owen, 2009). Therefore, controllers must be of a high calibre and the training rigorous to enable the trainees to withstand the job stress. Controller training involves constant, concentrated feedback to ensure that once working, controllers are competent and no longer require continuous supervision.

1.2 Context: Air Traffic Control Training

While there are some differences internationally in the management and training of controllers, New Zealand provides a general case in point. Because of the need for international standardization of air traffic management, the field of air traffic control represents a large networked community sharing similar concerns and issues. The primary concern is the safe and economic control of domestic and international air traffic. This begins with the training of competent controllers (French, 2009). The air traffic control community has identified several demographic characteristics of trainees which require further examination. These are, age, sex, and education level (Cavcar & Cavcar, 2009).

There is an ATC industry wide belief that older trainees (30 years or older) have higher failure rates during training than younger trainees. Indeed, in the United States, the Federal Aviation Administration imposes strict age limits for air traffic control trainees. This discriminatory higher practice operates with a special Act of Congress because of the widespread assumption that age affects training and performance (Greller & Simpson, 1999). Numerous organizations have concerns that older workers may exhibit lower productivity (Greller & Simpson, 1999). Aside from concerns regarding cognitive decline with age (Park, 1992) and susceptibility to stress with age (Net Industries, 2011), a possible explanation put forth for this negative perception of older trainees may be because older trainees are assumed

to be less open to receiving feedback than their younger counterparts. From another perspective, older trainees may be more critical of instructors and less docile in training contexts, as they bring a greater store of life experiences with them.

The ATC community has also expressed interest in potential sex differences, as the occupation is male dominated in New Zealand and indeed world-wide. ATC is classified as a 'non-traditional' career for females. A 'non-traditional career' is one in which more than 75 percent of the workforce is comprised of a single sex (Education that works, 2010). There is also international interest in the sex of controllers for equity purposes (Cavcar & Cavcar, 2009). ATC organizations would like to ensure equitable treatment, therefore they need to determine if males and females significantly differ in their failure rates in training and if this is the case, whether there is something they can modify in the training and feedback these trainees receive to rectify this difference.

There is also international interest in educational qualifications for controller trainees (Cavcar & Cavcar, 2009). The current philosophy of ATC training appears to be knowledge-centred rather than skill or task-centred (CAST, 1999). The majority of controllers have been educated through training provided by civil aviation authorities rather than colleges or other academic institutions and there are vast international differences in the actual application and methodology regarding controller training (Cavcar & Cavcar, 2009). For example, Ecole Nationale d'Aviation Civile (ENAC) in France, enrols graduates from an associate degree. Its educational period is three years (Cavcar & Cavcar, 2009). In addition, the Collegiate Training Initiative–Air Traffic Control Specialist (CTI–ATCS) of the Federal Aviation Administration (FAA) in the United States of America (USA) believes that the 'knowledge and skills acquired through a college education promote better performance and flexibility on the job' (Morrison, Fotouhi, & Broach, 1996, p. 1). Morrison et al. (1996) explain that at a general level a college education is believed to facilitate a comprehensive knowledge base in

ATC related subjects. This knowledge base is deemed necessary for individuals to cope with an anticipated increase in the demands of a controller's job (Morrison et al., 1996). In order to ensure this knowledge base, the FAA has implemented partnership agreements with thirteen universities and colleges in the USA (Cavcar & Cavcar, 2009). Cavcar and Cavcar (2009) conclude that France and USA's successful training programs can be examples for the other countries where controller training issues are already being discussed. These two countries' programmes require a far more substantial educational background than in New Zealand, which has a minimum entry requirement of NCEA Level 2[1] with some NCEA Level 3 credits. There is thus a large range in prior formal educational experiences amongst New Zealand trainee controllers. Additionally, Ree and Earles (1992) concluded that intelligence is the best predictor for job performance, therefore formal education, may play a role in trainees' success.

This research aimed to investigate the demographic information of controller trainees and how this affected performance during the six month theory and simulator based training and six month field training. This research also aimed to examine the affect the demographic characteristics of controller trainees had on the feedback provided to the trainees and trainee's response to the feedback during training. Airways Corporation[2] provided access to their database which includes the age, sex and highest education level of past trainees. The first study in this research investigated this data set to discover if trainees' demographic information predicted their success in the training period.

One hypothesis for the first study was that younger trainees would have higher pass rates than older trainees. This hypothesis was based on the special act of Congress in the

[1] The National Certificate in Educational Achievement (NCEA) is New Zealand's main national qualification for secondary school trainees. There are three levels (1-3), starting at Year 11 through to Year 13.
[2] Airways oversee air traffic management in New Zealand. They are a State-owned Enterprise, a fully-owned subsidiary of the NZ Government operating as a commercial business.

USA which restricts the age of controller trainees and the assumption by Greller and Simpson (1999) that age affects training and performance. Another hypothesis for this study was that the pass rates for males and females would be similar. This hypothesis aimed to investigate the disproportion of males to females in the ATC occupation and to discover if the disproportion is due to differences in ability between males and females. The final hypothesis for this study was that trainees with post-secondary education would have higher pass rates than trainees with a high school education. This hypothesis was based on the discrepancy between New Zealand and international education requirements (Cavcar & Cavcar, 2009) as well as conclusive evidence which indicates that intelligence is the best predictor of job performance (Ree, & Earles, 1992).

The second study also assessed if the demographics, age, sex and education level affected trainees' outcomes (pass/fail) during training. Furthermore study 2 observed performance feedback after simulator based training at Airways training centre. If feedback is related to certain demographic characteristics, then it would be most apparent during the simulation training because simulator based training involves a trainee and instructor acting out scenarios an ATC may experience while working. At the end of each simulation, the instructor debriefs the trainee, summarising their performance and provides positive and negative feedback.

This second study aimed to test existing findings on feedback and performance. For example, a study conducted by Goodman (1998) found that high task feedback increased learning and performance. Therefore, this study measured the level of explanation (by word counts) provided by the instructors to the trainees. Additionally, as discussed by Herold and Fedor (2003) research has found that instructors may adjust their feedback based on personal assessments of the trainer. Therefore, air traffic control instructors could be (with or without

awareness) adjusting their feedback for older trainees based on their age and the industry wide belief, that older trainees have higher failure rates. It is important to have evidence based practice and that is why this research also measured the use of positive and negative words in the feedback given to the trainees by the instructors.

This study also investigated the idea that different circumstances of the feedback may evoke different responses (Herold & Fedor 1998). That is, the manner in which the feedback is provided by the instructors may generate different responses within the trainees. Therefore, the study also measured the use of positive and negative words and the word counts by the trainees. Word counts were chosen as a variable because they provide an indication of the volume of feedback instructors are providing the trainees as well as indicating the amount of response the trainees are giving to this feedback. Ratios of positive to negative words were chosen because there is extensive research surrounding ratios in communication. This research began with John Gottman's exploration of positive to negative ratios in marriage (The Gottman Institute, 2010). Using a 5:1 ratio, which Gottman dubbed 'the magic ratio,' he and his colleagues predicted whether 700 newlywed couples would stay together or divorce by scoring their positive and negative interactions in one 15-minute conversation between each husband and wife (The Gottman Institute, 2010). Ten years later, the follow-up revealed that they had predicted divorce with 94 percent accuracy (The Gottman Institute, 2010). Building on this research, Fredickson and Losada (2005) concluded that at least 2.9 positive things should be said or done for any one negative thing. For example, teams identified as being highly productive tended to have 5 to 6 positive utterances to every negative utterance, while the least productive teams tended to have slightly more negative than positive utterances (Fredickson, & Losada 2005). Fredickson and Losada (2005) also discovered that there is an upper limit for effective positive-to-negative ratios which is 11.6 to 1. Therefore, it

was important to investigate these ratios for the trainees during their feedback at the training centre as they could be an important factor in their success or failure at the training centre.

Investigating these variables could potentially benefit the training process for controllers. For example, the type of feedback and the manner in which the feedback is given during simulation training may need to be adapted to suit the individual needs of each trainee and, perhaps, be adjusted given their demographic characteristics. This idea of differentiation is well known within education as people learn differently (New Zealand Curriculum Online, 2010). Put simply, teachers alter their teaching approach to the needs of the individual trainee to optimize the trainee's learning experience. This could be something the ATC community could explore for the training of controllers.

The first three hypotheses for this study were the same as the hypotheses for Study 1. These were: that younger trainees would have higher pass rates compared to the older trainees; that the pass rates for males and females would be similar; and that those trainees with post-secondary education would have higher pass rates than trainees with a high school education.

The next four hypotheses were based on the feedback between instructors and trainees. The first hypothesis was that older trainees would respond to the feedback given to them by their instructors with different word counts and ratios of positive to negative words compared to the younger trainees. It was not hypothesised how the word counts and ratios will differ, just that there would be a difference between the older and younger trainees. Research supports this hypothesis. Wild-Wall, Willemssen and Falkenstein (2008) found that older participants had a reduced ability to use feedback information for improving on a task. This potentially means that the older trainee's response to feedback is hindering their performance.

The second hypothesis was that the word counts would be higher for trainees with post secondary education than for high school educated trainees and the ratios of positive to negative words would also differ between the two education levels. Again, it was not hypothesised how the ratios would differ, just that they would differ between trainees with post-secondary education and trainees with high school education. This was based on the different learning environments experienced by trainees with a high school education and trainees with post secondary education. For example, Universities allow students to explore and share with others the way in which they think in order to become more effective problem solvers (Verschaffel, Dochy, Boekaerts, & Vosniadou, 2006). However, this training in symbolic logic, considered essential as a critical thinking skill, is absent from most high schools (Verschaffel et al., 2006). It is likely that trainees with post secondary education would have been encouraged to share and debate their ideas and learning to a greater extent than their counterparts with high school education.

The third hypothesis was that male trainees would have higher word counts and better ratios of positive to negative words than female trainees. This hypothesis was based on the finding by Tannen (1990) that, despite stereotypes of women as being talkative, adult men talk more in meetings, in the classroom, and in mixed-group discussions than adult women. This hypothesis was also based on the finding by Deci and Ryan (1985) who found that when praised, females tend to experience the communication as more controlling than males do. They also discovered that there was a tendency for positive verbal feedback to have a more detrimental effect on their intrinsic motivation and self-determination (Deci & Ryan 1985). Obviously all three hypotheses would be somewhat influenced by the feedback the instructors provide the trainees. Therefore, the final hypothesis was that the word counts and ratios the instructors provide in their feedback to the trainees would differ as a function of the trainee's age, sex and education level. This was based on the research discussed by Herold and Fedor

(2003) that instructors consciously or not make personal judgements about trainees and this can influence the feedback they provide.

In summary, the present research comprises two studies. The first study investigated the relationship between demographics such as age, sex and education level, and pass/fail rates at a training centre. The second study investigated the impact of these same demographics on the feedback given and received in a training centre as well as the outcomes (pass/fail) of trainees. This research has significance for anyone who travels by air, now or in the future. The safety of all air travellers is in the hands of ATCs, therefore travellers have a vested interest in the training of controllers.

Chapter 2: Study 1

2.1 Overview

The three demographic characteristics that this study focused on were: age, sex and education level. These characteristics all have links to current overseas ATC practices. In the USA a maximum age of thirty years has been established for entry into civilian air traffic control positions in the Federal Aviation Administration (FAA, n.d.). In New Zealand air traffic controllers have no maximum age for entry, only a minimum entry age of 20. There is a worldwide sex imbalance for ATCs as it is male dominated. ATC is considered a non-traditional career for women (Education that Works, 2010) a non-traditional career is one in which there is an imbalance of sexes (where fewer than 25% of the workers are either females or males). There is international interest in this sex inequity within the ATC community. Finally, the education levels of ATCs overseas, particularly in France, but also increasingly in the United States and elsewhere, exceed the education requirements of prospective ATCs in New Zealand. For example, in the USA, the FAA has partnerships with many colleges and universities. These schools offer two and four-year, non-engineering

aviation degrees that teach basic courses in air traffic control (FAA, n.d.). These programmes are specifically designed to provide qualified applicants to fill developmental ATC specialist positions (FAA, n.d.). This study aims to examine the relationship between the educational demographic and the outcome of trainee's time during training. The three hypotheses for this study were that younger trainees would have higher pass rates compared to the older trainees; that the pass rates for males and females would be similar; and that those trainees with post-secondary education would have higher pass rates than trainees with a high school education.

This study also looked at the rates of failure during field training. Once trainees have completed their six month theory and simulation training, they spend a further six months training in one the regional towers around New Zealand (Airways, 2010). When trainee's fail in the field, the cost for Airways increases immensely, therefore it is important to discover which groups have the highest likelihood of failure during this period. If certain groups can be identified as having an increased probability of failure during this period, the ATC training community can either focus more attention on these groups and develop methods to decrease failure rates in these groups or alter their recruitment criteria to optimise the success rates of trainees.

2.2 Method

2.2.1 Participants.

A data set of 635 trainees was received from Airways; however only 159 participants had age, sex, education level and outcome data. Only participants for whom the full range of data was available were included in this study. In this data set there were 110 (69.2%) participants younger than 30 years and 49 (30.8%) participants who were 30 years or older. The participant group included 116 males (73%) and 43 females (27%). Education level was assessed in two categories: those with a maximum of high school education and those with

post-secondary education. There were 32 (20.1%) high school educated participants and 127 (79.9%) participants with post-secondary education. Post-secondary education describes any education received beyond high school years such as, a University degree or a trade qualification. Participants were past trainees at Airways Training Centre in Christchurch, New Zealand.

2.2.2 Procedure.

A data set was received from Airways and then analysed using SPSS ("SPSS for Windows", 2005).

2.3 Results

Preliminary analysis investigated the descriptive statistics of the data which contained the age, sex, education level and outcome (pass or fail during training) of past and present trainees. To align with international ATC industry standards overseas the education level was coded into two categories – high school education = 0 and post-secondary education = 1[3]. Firstly, a frequency procedure was conducted on this data set. Table 1 shows the frequencies and percentages of the outcome variable separated into groups by the three independent variables; age, sex and education level.

[3] There were no differences in results when education level was further broken down.

Table 1

Frequencies of Age, Sex, Education Level and Outcomes (Pass/Fail)

Education Level	Sex	Age	Fail Frequency	Fail Percent	Pass Frequency	Pass Percent	Total Frequency	Total Percent
High School	Male	<30	4	26.7	11	73.3	15	100.0
High School	Male	30+	3	42.9	4	57.1	7	100.0
High School	Female	<30	4	50.0	4	50.0	8	100.0
High School	Female	30+	1	50.0	1	50.0	2	100.0
Post Sec.	Male	<30	15	22.7	51	77.3	66	100.0
Post Sec.	Male	30+	9	30.0	21	70.0	30	100.0
Post Sec.	Female	<30	4	16.7	20	83.3	24	100.0
Post Sec.	Female	30+	4	40.0	6	60.0	10	100.0

Table 1 shows that high school educated, young males had a 73.3% pass rate while high school educated, older males had a 57.1% pass rate. Conversely, high school educated, young females had a 50% pass rate as did high school educated, older females. Table 1 shows that participants with post-secondary education in each of the age and sex categories had higher pass rates than those who were high school educated. Young males who had a post-secondary education had a pass rate of 77.3%, while older males with a post-secondary education had a pass rate of 70%. Young females with a post-secondary education had the highest pass rate of 83.3% out of all the groups and older females with a post-secondary education had a 60% pass rate.

A chi-square test was conducted on each of the three independent variables, age, sex or education level, to see if they could predict if a trainee would pass or fail the training centre. None of the independent variables could predict the outcome of a trainee's time at the training centre; the results were non-significant (see Appendix B).

Despite the failure to detect significant differences for the demographics, in real world cases sometimes fast and frugal heuristics, such as "take-the-best," outperform statistical techniques (Gigerenzer & Goldstein, 1996). The present case looked at the three

demographic pieces of information, education, age, and sex, and rank ordered them in ability to differentially predict failures (e.g., absolute difference in failure rates). Education proved to have the largest absolute difference in failure rates (e.g., largest predictive difference). Those with a high school education had a failure rate of 37.5% and those with post-secondary education had a failure rate of 24.6%. The next most discriminative demographic was age, with those younger than 30 years having a 23.8% failure rate, while those older than 30 years having a 37% failure rate. The least discriminative demographic was sex, with males having a 26.3% failure rate, and females having a 41.9% failure rate. If Airways were looking for a simple discriminative heuristic, the best (e.g., most discriminative cue) would be education.

There are two stages that trainees at Airways must pass to become qualified Air Traffic Controllers. The first stage is at the training centre, the second is in the field. Failing in the field is significantly more costly than failing in the training centre. It has been calculated that the cost to Airways of a trainee failing at the first stage of training is $11,666 per trainee, whereas the minimum cost of a trainee failure during their field training is $51,380. The cost of failure during the training centre stage varies greatly depending on a number of aspects, including the number of trainees and classes. Additionally there is no average cost for failure in the field as trainees fail at different times during this period but no trainee can fail in the first four months. $51,380 is the minimum cost of failure in the field at this stage. Due to the different costs associated with each stage, it is important to investigate the predictors of failing each stage, separately. To do this, a frequency procedure was conducted on the data set, with the variables age, sex, education level and outcome set to identify the stage at which most people failed.

Table 2

Frequencies of Stages of Failure for ATC Trainees

	Frequency	Percent
Training Centre	26	16.4
Field	16	10
Pass	117	73.6
Total	159	100.0

Table 2 shows that the stage with the highest rate of failure was the training centre, 16.4% of trainees failed at this stage, compared to 10% of trainees who failed in the field.

Table 3

Stage of Failure by Age

Age	Stage of failure	Frequency	Percent
<30	Pass	86	78.2
	Fail at Training Centre	15	13.6
	Fail in the Field	9	8.2
	Total	110	100.0
30+	Pass	31	63.3
	Fail at Training Centre	11	22.4
	Fail in the Field	7	14.3
	Total	49	100.0

Table 3, shows that 13.6% of younger trainees failed at the training centre compared to 22.4% of older trainees who failed at the same stage. Younger trainees failed in the field 8.2% and older trainees failed 14.3% in the field.

Table 4
Stage of Failure by Sex

Sex	Stage of failure	Frequency	Percent
Male	Pass	86	74.1
	Fail at Training Centre	18	15.5
	Fail in the Field	12	10.3
	Total	116	100.0
Female	Pass	31	72.1
	Fail at Training Centre	8	18.6
	Fail in the Field	4	9.3
	Total	43	100.0

Table 4 shows that 15.5% of males failed at the training centre, while 18.6% of females failed in the training centre. Males failure in the field was 10.3% compared to females 9.3%.

Table 5
Stage of Failure by Education level

Education Level	Stage of failure	Frequency	Percent
High School	Pass	20	62.5
	Fail at Training Centre	10	31.25
	Fail in the Field	2	6.25
	Total	32	100.0
Post-secondary	Pass	97	76.4
	Fail at Training Centre	16	12.6
	Fail in the Field	14	11.0
	Total	127	100.0

Table 5 shows that a higher percentage of trainees with high-school education (31.25%) failed during the training centre compared to those trainees with post-secondary education (12.6%). The opposite was true for failure rates in the field; there were fewer failures by trainees with high school educations (6.25%) compared to trainees with post-secondary educations (11%).

It was important to investigate these stages of failure including all three variables, age, sex and education level to identify which combination of demographic characteristics (sub group) would provide Airways with the lowest failure rates in both the training centre

and the field. A Fisher's exact test was done for the three demographic variables: age, sex and education level. There were no significant results (see Appendix C). Instead, Table 6 shows the frequencies and percentages of the stages of failure, separated into groups by the three independent variables, age, sex and education level.

Table 6
Frequencies of Age, Sex, Education level and Stage of failure

Age	Sex	Education Level	Pass Frequency	Pass Percent	Fail at Training Centre Frequency	Fail at Training Centre Percent	Fail in the Field Frequency	Fail in the Field Percent	Total Frequency	Total Percent
<30	Male	High School	11	73.3	4	26.7	0	0	15	100.0
<30	Male	Post-secondary	51	77.3	5	7.6	8	12.1	64	100.0
<30	Female	High School	4	50.0	3	37.5	1	12.5	8	100.0
<30	Female	Post-secondary	20	87	3	13	0	0	23	100.0
30+	Male	High School	4	57.1	3	42.9	0	0	7	100.0
30+	Male	Post-secondary	20	66.7	6	20.0	4	13.3	30	100.0
30+	Female	High School	1	50.0	0	0	1	50.0	2	100.0
30+	Female	Post-secondary	6	60.0	2	20.0	2	20.0	10	100.0

Table 6 shows that the most common stage of failure for controller trainees was at the training centre. Young males with a high school education had a 26.7% failure rate at the training centre. This was the only stage of failure for this group. However, young males with post-secondary education, had a 7.6% failure rate at the training centre compared to a 12.1% failure rate in the field. This was one of the two groups in which higher failure rates were found in the field than in the training centre. Young females with high school education had failure rates of 37.5% in the training centre compared with a 12.5% failure rate in the field. Younger females with post-secondary education had failure rates of 13% during the training centre. For older males with high school education, 42.9% of trainees failed during the training centre, compared to older males with post-secondary education with a 20% failure

rate at the training centre, and a 13.3% failure rate in the field. Older females with high school education had a 50% failure rate in the field (there were no failures during the training centre for this group). Older females with post-secondary education had a 20% failure rate at the training centre and a 20% failure rate in the field.

Because the cost of failure at both the training centre and during field training was known, a risk analysis could be calculated to investigate which sub-group of trainees pose the greatest potential cost or risk for Airways. This was done by calculating the cost of failure at each stage by the percentage from each sub-group who failed either during the training centre or in the field (See Appendix D). Due to the different number of trainees in each sub-group the percent of failure was multiplied by the cost of one failure, to ensure the sub-groups with larger numbers of trainees would not be over represented. Table 7 outlines the results from the risk analysis.

Table 7

Risk Analysis of Each Sub-group for Failure during ATC training

Sub-group	Potential Cost/Risk $
<30 F Post Sec.	1458.25
<30 M H.S	3114.82
30+ M H.S	5004.71
30+ M Post Sec.	9166.74
<30 F H.S	10797.25
30+ F Post Sec.	12609.2
<30 M Post Sec	15391.42
30+ F H.S.	31523

Table 7 shows that the sub-group that historically had the highest risk, given the data available were older females with a high school education at a potential cost of $31523. The sub-group that historically had the lowest risk were younger females with post-secondary education at a cost of $1458.25.

2.4 Discussion (Study 1)

This study examined the relationship between trainees' demographic characteristics and their success or failure rate during air traffic control training. The trends in the data provide support for the hypothesis that trainees younger than 30 years of age would have higher pass rates than their older counterparts. The trends in the data also provide support for the hypothesis that education level would influence the outcomes (pass/fail) of controller trainees. Finally, the trends also support the hypothesis that there would be no sex differences in the outcomes of trainees during their training.

Many theorists have debated the use of traditional statistical modelling and have concluded that in some contexts analysis is not appropriate (Markus, 2001). Taleb (2007) argues that because of the information overflow in today's society, people often fail to interpret data accurately therefore creating correlations that are not always relevant, when randomness more often is the rule. Statistical analysis was conducted for this study however no tests were statistically significant for the current data set. In the real world sometimes rational decisions have to be made with limited data and this study was one of those cases. Additionally, examining patterns within the data can contribute valuable information.

The first part of the results investigated the frequencies of passes or failures by trainees separated by their age, sex and education level. These frequencies showed that younger trainees had higher pass rates compared to the older trainees. These frequencies followed the predicted trend for the hypothesis of age differences. Those trainees with post-secondary education had consistently higher pass rates compared to those with high school educations irrespective of age or sex. This finding supported the hypothesis that the education level of trainees would influence the outcomes (pass/fail) during training. For the younger trainees, both male and female, their pass rates were very similar, in comparison to the older trainees, where males had slightly higher pass rates than females. This finding also supported

the hypothesis that the sex of trainees would not influence the outcomes (pass/fail) during training. When looking at the trainees separated into sub-groups by the three variables, age, education level and sex, young women with a post-secondary education had the highest pass rates.

The frequencies investigated in this study followed the predicted trend for the first hypothesis that older trainees would have higher failure rates compared to the younger trainees. This finding corresponds with FAA standards that do not allow people older than 30 years to begin controller training (FAA, n.d.). The special act of Congress which allows this restriction is influenced by much research in the field of Applied Psychology, for example, Speilberger (2004) describes how cognitive functioning begins to decline from the age of 30 years on. However, this should be qualified by the fact that the difference was not statistically significant. Therefore, further research is needed with a larger more complete data set. Alternatively, future research could address the missing data in this study and if possible fill in the missing data to ensure the full data set of 635 trainees could be used.

The findings also followed the predicted trend for the second hypothesis that education level would influence the pass rates of trainees. The finding that trainees with post-secondary education outperformed trainees with high school education was also consistent with existing literature. The Institute for Higher Education Policy found that trainees who attended University or College had higher workplace productivity (1998). This finding has important implications for the company and ATC training in general. Currently the education requirement for prospective ATCs in New Zealand is NCEA Level 2[4], which is considerably lower than the requirements for many overseas ATC Training Colleges (FAA, n.d.). The results of the present study suggest that educational prerequisite for controller trainees should be further investigated for ATC training in New Zealand. This also aligns with the increased

[4] NCEA Level 2 is the equivalent of Sixth form Certificate with trainees being 16-17 years old.

literacy requirements for University Entrance beginning in 2011 as universities in New Zealand decide that education requirements in New Zealand need to be more robust to meet international standards (NQZA, 2010).

The finding that those with post-secondary education had consistently higher pass rates compared to those trainees with a high school education suggests that the air traffic control community may wish to focus recruitment efforts in universities to attract those trainees who may have higher success rates at the training centre due to their university education. Future research could continue to investigate the finding that trainees with post-secondary education have higher pass rates than trainees with a high school education. If future research endorsed this finding, ATC organizations, such as Airways, could explore the option of increasing their education prerequisites for prospective trainees. However, one concern is the slightly lower pass rate in the field for post-secondary educated trainees (discussed more below).

Additionally, the fact that there were not significant sex differences in the outcomes of trainees could have important implications for the international ATC community. Typically, ATC is a male dominated occupation (Education that works, 2010). In this study alone, 73% were males with only 27% females. Furthermore, when the trainees were separated into sub-groups by the three demographic variables, age, education level and sex, young women with a post-secondary education had the highest pass rates at the training centre. These two findings indicate that the inequity of sexes in the ATC occupation is not due to a difference in ability between the sexes. The reason for the sex imbalance in the ATC occupation is something the air traffic community may wish to further investigate. No difference in the ability between sexes as been found, ATC organizations could perhaps make changes to their marketing and recruitment processes to try and attract more females to the role. ATC training programmes all over the world, could adopt targeted recruitment:

investing in advertising to attract the most suitable female trainees and help reduce the known shortages of controllers (French, 2009).

This study also investigated the influence of demographic variables on the stage of training during which the trainees failed. The cost of a trainee failing during the six month training centre was calculated to be $11,666 per trainee and the cost of a trainee failing in the field was $51,380. The data set which included age, sex, education level and the outcome (pass/fail) was broken down into three options – pass, fail at the training centre or fail in the field. It was found that the most failures occurred during the training centre. These frequencies revealed that there were fewer failures by younger trainees at both the training centre and in the field. These results followed the trend of the first hypothesis, that older trainees would have higher failure rates than the younger trainees. Females had slightly higher failure rates during training compared with the males but the failures in the field were very similar. This again supports the third hypothesis that sex would not influence the outcomes (pass/fail) of training. Additionally, trainees with a high school education had much higher failure rates at the training centre and slightly lower failure rates in the field compared to those trainees with post-secondary education. This could possibly be explained by the different learning environments trainees experience during their training. Trainees spend six months in the training centre which is similar to a class room environment, and then six months in the field, in control towers, at airports around the country. These different learning environments entail a different set of learning competencies. The class room requires individual, studious, and focussed learning whereas the field requires working in a team, using resourcefulness and showing initiative. Resnick (1987) described how the dominant form of school learning and performance by individuals is ultimately judged on what they can do by themselves. In contrast, much activity outside school is socially shared. Work takes place within social systems, and each person's ability to function successfully depends on

what others do and how several individuals' mental and physical performances mesh (Resnick, 1987). This is similar to the pattern of learning at Airways, which begins in the classroom and then proceeds to the field. For the first six months, much of the learning takes place in a classroom setting and has an individual focus. However, once trainees are placed in an air traffic control tower at an airport to complete their field training, they must work with many people, outside that classroom environment. Perhaps trainees who have less education are not as comfortable in the classroom in an individually-based learning environment, as they may be in the field environment. Additionally, trainees with post-secondary education have spent longer in the individual based learning system and may thrive in the initial classroom based environment, but find the change to the field environment more difficult. The implication for ATC community is that maybe two different sets of competencies are required for success during the one year controller training. Future research is needed to explore if these differences exist. If they do in fact exist, changes may need to be made to both stages of training to ensure the required competencies align with both aspects of training.

The stages of failure were then investigated after breaking the three independent variables, age, sex and education level, into sub-groups to assess which sub-group would have the lowest failure rates at either stage of ATC training. Looking at the percentages of each stage of failure, trainees with post-secondary education, irrespective of age or sex, consistently had lower failure rates at the training centre compared to trainees with a high school education. The results were not as straight forward for failure rates in the field. For young males with high school education there were fewer failures in the field compared to those with post-secondary education. Older males had similar patterns to their younger counterparts; there were no failures in the field for those with a high school education. For young females there were no failures in the field for those with post-secondary educations.

Older females also followed the same pattern as their younger counterparts, with trainees with high school educations having higher failure rates in the field in comparison to those trainees with post-secondary education. These percentages indicate that overall trainees with post-secondary educations will have higher pass rates at the training centre, than trainees with a high school education. It is important to note however, that due to the considerable amount of data missing there were different sample sizes for each of the sub-groups, in particular high school educated trainees (20.1%) appeared to be under represented in comparison to trainees with post-secondary education (79.9%). Therefore, future research with complete data is needed to further investigate the differences between these sub groups. Irrespective of age, female trainees with post-secondary education had lower failure rates in the field than female trainees with high school education. Perhaps females with post-secondary education, with greater educational experience, have more confidence to ask questions in the field and to probe for more information, compared to females with high school education. Verschaffel et al., (2006) proposed that people with post secondary education would have been encouraged to share and debate their ideas and learning to a greater extent than their counterparts with high school education. This finding was not consistent with the trends for males, as those with a high school education had lower failure rates in the field compared to those with post-secondary educations, irrespective of age. This sex difference needs further investigation, (there could be an anomaly with the data as the sample size for each sub group differs). Alternatively there may be another as yet to be identified variable which is influencing the outcomes (pass/fail) of the different sub groups.

The trainees with the lowest rates of failure were young women with post-secondary education. It is difficult to draw conclusions about why this sub-group had the lowest failure rate overall, without further research. As already stated, there may be an issue with sample

size; however, these findings show that the ATC community need to investigate these differences further.

A simple 'risk analysis' was calculated using the data set, that is, the financial investment Airways is risking for each type of person given their demographic characteristics. The risk analysis found that if Airways want to reduce their financial risks, the best sub-group for successful controller training are younger women with post-secondary education. The next best sub-group was younger males with high school education. The most 'risky' sub-group was older females with high school education. First and foremost Airways is a business and therefore the cost involved in training trainees to become controllers is important. This analysis shows that younger females with post-secondary education are the most likely trainees to succeed. They pose the least risk of failure and so are potentially the lowest cost group for Airways to train.

2.4.1 Implications

The current findings begin to create an understanding of who the ideal people to successfully complete the training to become controllers. It is important to note that this study is highly context specific. The focus in this study was to identify the most likely trainees to successfully complete the controller training. This does not necessarily mean they will be the best controllers. The investigation into the stage of failure of trainees after they were separated by the three demographic variables (age, sex and education level) showed that young women with post-secondary education had the highest pass rates for this study. A reason for this could perhaps be that young women with post-secondary education fulfil the attributes of an ATC trainee (as outlined by Airways[5]) to the highest degree of any of the sub-groups. However, the fact that males with post-secondary education do better at the training centre than males with a high school education, but then do worse than the males with a high

[5] Commitment, energy and drive, open to feedback, willing to learn, confidence, resilient, flexible, good communication, team player, takes responsibility (Airways, 2010).

school education in the field, is puzzling. Obviously, the set of competencies required to learn in a 'classroom' environment are quite different to those required in the field which is perhaps a reason for this difference. This difference requires more research, in particular why males with post-secondary education have higher failure rates in the field than they do during the training centre. Understanding this difference could have significant financial implications for the ATC community. If the failures of males with post-secondary education during the field could be reduced, organizations such as Airways could save a minimum of $51,380 per trainee per failure. Again this could be a sample size issue, therefore, the ATC community should examine these differences further. Future research may want to investigate other information about trainees during their entire time training to become an ATC. There could be many other variables which cause different sub-groups to perform better or worse during the stages of training and this needs further research.

2.4.2 Limitations

There were a number of limitations in this study. Firstly, significant data was missing in the data set supplied by Airways. This meant that only one third of the data available could be analysed. Future research would benefit from the provision of a complete data set. Additionally, because the data was grouped by age, sex, education level and the stage of failure or success, the sample size for each group varied, and was, in some cases, quite small. Future research would benefit from a larger participant pool, with complete data. Airways can only train a few classes of controllers each year. Each class has a maximum size of 15 because of the intense nature of the training, the facilities available and the number of qualified controllers available to teach. Therefore, collecting data over a ten year period would provide a participant pool of around 600 trainees, which would allow for more detailed

analysis. Ideally, future studies would also have the same number of trainees for each of the eight categories of demographic characteristics, to ensure validity and reliability of analysis.

Chapter 3: Study 2

3.1 Overview

Study 1 focused on the relationship between the demographic characteristics of age, sex and education levels and trainees' outcomes during training to become controllers for an historic data set. Study 2 will investigate if these demographics play a role in the type of feedback the trainees receive and the response they give to the feedback in a smaller cohort of current trainees. People experience feedback daily, in every facet of their lives, including the workplace. Previous research has usually focused on the person giving the feedback, less research has concentrated on the person receiving the feedback (Herold and Fedor, 1998). Research is now highlighting that there are differences in how people receive feedback and learn; that is why the New Zealand Curriculum and other educational research is now promoting 'individualised learning' as the key to effective education (NZCO, 2010). This could be valid research for the International ATC community to consider at all their training centres.

This study aims to investigate if the age, sex and education level of trainees, influence their word counts and ratios of positive to negative words in response to the feedback they receive during their training. The interactions between trainees and instructors will be analysed to see if there are any patterns between these interactions and the trainees who passed, compared to those who failed at the training course. If there are clear differences in the interactions between trainees who passed and trainees who failed, then perhaps air traffic control organizations such as Airways, could provide additional help to those 'at risk' trainees early in the training, to ensure that these trainees succeed. Alternatively they could decide to have earlier exit strategies for failing trainees.

The first three hypotheses for this study were the same as the hypotheses for Study 1. These were that younger trainees would have higher pass rates compared to the older trainees; that the pass rates for males and females would be similar; and that those trainees with post-secondary education would have higher pass rates than trainees with a high school education.

The next four hypotheses were based on the feedback between instructors and trainees. The first hypothesis was that older trainees would have different word counts and ratios of positive to negative words in response to feedback compared to the younger trainees. It was not hypothesised how the word counts and ratios would differ, just that there would be a difference between the older and younger trainees. The second hypothesis was that the word counts would be higher for trainees with post secondary education than for high school educated trainees and their ratios of positive to negative words would also differ between the two education levels. Again, it was not hypothesised how the ratios would differ, just that they would differ between trainees with post-secondary education and trainees with high school education. The third hypothesis was that male trainees would have higher word counts and better ratios of positive to negative words than female trainees. The final hypothesis was that the word counts and ratios the instructors provide in their feedback to the trainees would differ as a function of the trainee's age, sex and education level.

3.2 Method

3.2.1 Participants

The participants were 16 trainees (10 male) at Airways Corporation. They were two classes, each with eight trainees. There were twelve trainees younger than 30 years of age, and four trainees older than 30. There were six trainees with high school education and ten trainees with post-secondary education. Post-secondary education is any education above

high school including a university degree, a trade or a polytechnic course. Participation was voluntary. The trainees were provided with information regarding their involvement, and if they wished to take part, they provided their written consent prior to any data being collected. All instructors provided their written consent.

3.2.2 Apparatus and Stimuli

Controller trainers at Airways must complete a series of immersive tower simulation exercises as part of their six month training at the training centre. In these simulations the trainees take control of the tower under the supervision of an instructor. Small Panasonic recording devices (IC Recorders) were used to record the interactions in each simulation and debrief session. The IC recorders were placed on the desk in the simulators at the beginning of every session and each instructor would initiate recording at the beginning of their individual session. This minimised interruption during the simulations and the debrief sessions. A programme 'Cool MP3 Splitter' was used to separate the simulation exercise recordings from the debrief recordings.

All interactions and subsequent transcriptions were stored on a personal laptop with password access. The transcribed text was analysed using the computer programme - The General Inquirer. This programme acts as a mapping tool; it maps each text file with counts on dictionary-supplied categories (The General Inquirer, 2002). The currently distributed version combines the "Harvard IV-4" dictionary content-analysis categories, the "Lasswell" dictionary content-analysis categories, and five categories based on the social cognition work of Semin and Fiedler. Each category is a list of words and word senses (The General Inquirer, 2002). The General Inquirer was used to measure the word count and the use of positive and negative words during each trainee's simulation run. Word counts were chosen because they provide an indication of the volume of feedback instructors are providing the trainees as well

as indicating the amount of response the trainees are giving to this feedback. The use of positive to negative word ratios were chosen because there is extensive research which has examined the ratios of positive to negative during communication (Fredickson, & Losada, 2005).

3.2.3 Procedure

Data was collected from simulation runs at Airways Corporation. Before this data was collected, all trainees and instructors were provided with information on the study and asked for their consent to participate in the study. The trainees were doing Aerodrome Approach or Approach Control simulation exercises. At the end of each trainee's simulation their instructor would provide them with performance feedback.

At the beginning of each session, recording devices were placed in the simulators. Only the instructor and the trainees were in the simulators at the time of recording. At the beginning of each recording, the instructor would say the name of the trainee to allow for all trainees' recordings to be linked together. During each simulation the instructors provided feedback to the trainees, wherever they saw fit. In addition, at the end of every simulation, the instructor debriefed the trainee about their performance in the simulation exercise. The trainees did not always have the same instructors, there were different instructors for each class, and they rotated around the trainees.

At the end of each recording session, the files were labelled and transferred onto a laptop. Then all files on the devices were erased. Each trainee had five debriefs recorded. This repetition was necessary because this study aimed to observe the interactions between instructors and trainees over a period of time to investigate if any predictions could be made about a trainee's success or failure at the training Centre based on these interactions. Once all the data had been collected, they were edited using the programme 'Cool MP3 Splitter'

which split the simulation exercises from the debriefs. The debriefs were then transcribed into word documents.

Although all the recordings of debriefs were transcribed, only random samples of the debriefs were analysed. Systematic random sampling was used to analyse the data. For a content analysis to be generalizable, the sample for analysis should be selected randomly (Neuendorf, 2002). A software programme was used to take random samples of the classes recordings to ensure that all the recordings were about ten minutes in length.

Once the transcribing was complete, the transcribed Word Documents were run through the General Inquirer. The data from this program was entered into an Excel spreadsheet and analysed using the SPSS statistical software program ("SPSS for Windows", 2005).

3.3 Results

There were no differences between the two classes, therefore the two classes were analysed as one sample. Additionally, preliminary analysis found no differences between the instructors either. Descriptive statistics were investigated for this data examining who passed and who failed the training course (refer to Table 8).

Table 8
Training Outcomes as a function of Trainees' Age, Sex and Education

Trainee	Outcome	Age	Sex	Education Level
1	Fail	<30	M	H. School
10	Fail	<30	F	H. School
11	Fail	<30	M	H. School
16	Fail	<30	F	H. School
2	Pass	30+	M	Post Sec.
3	Pass	<30	M	Post Sec.
4	Pass	<30	M	Post Sec.
5	Pass	<30	F	Post Sec.
6	Pass	<30	M	Post Sec.
7	Pass	30+	M	Post Sec.
8	Pass	30+	M	Post Sec.
9	Pass	<30	F	H. School
12	Pass	<30	M	Post Sec.
13	Pass	<30	M	Post Sec.
14	Pass	30+	F	Post Sec.
15	Pass	<30	F	H. School

Table 8 shows that four out of the 16 trainees in the two classes failed the training course. Of those who failed, all of them were younger trainees, and two were females and two were males. All of those trainees who failed had high school educations.

Because of the small sample size (N=16), the demographic differences were analysed with Fisher's Exact tests for the 3 demographics: sex, age, and education independently. Education was significant $p = .0082$; 4 out of 6 (i.e, 66.7%) with a high school education failed, and 0 out of 10 (i.e., 0%) with a post-secondary education failed. Neither of the other 2 demographics was significant. These variables were then examined as frequencies (refer to Table 9).

Table 9
Frequencies of Age, Sex, Education level and Outcomes (pass/fail)

Age	Sex	Education Level	Pass Frequency	Pass Percent	Fail Frequency	Fail Percent	Total Frequency	Total Percent
<30	Male	High School	0	0	2	100	2	100
<30	Male	Post-secondary	6	100	0	0	6	100
<30	Female	High School	2	50	2	50	4	100
<30	Female	Post-secondary	1	100	0	0	1	100
30+	Male	Post-secondary	2	100	0	0	2	100
30+	Female	Post-secondary	1	100	0	0	1	100

Table 9 shows the frequencies of these variables. For example, young men with high school education had a 100% fail rate, compared to young males with post-secondary education who had a 100% pass rate. For young women with high school education, there was a 50% pass/fail rate compared to a 100% pass rate for young women with post-secondary education. Older trainees, both males and females who all had post-secondary education, had 100% pass rates.

Following Table 9, the differences between trainees for the number of words used during episodes one and two by both their instructor and the trainee were investigated. To

calculate these differences between trainees, the average number of words used by both the instructor and the trainee during episodes one and two were calculated for each trainee. An episode refers to each debrief between trainee and instructor. Due to the small sample size and the exploratory nature of this part of the study, the patterns and trends in the data were examined.

Table 10

Average Word Counts of Instructors and Trainees during Episodes 1 and 2

Trainee	*Average Instructor*	*Average Trainee*
1	1495.5	178
2	1022	301
3	1523	628
4	640.5	316.5
5	1046.5	97
6	1008	105.5
7	2166.5	435.5
8	674	379
9	857.5	368.5
10	698.5	425.5
11	570.5	205.5
12	701	324
13	827.5	173
14	641.5	466.5
15	521	400.5
16	465	374.5

Additionally, the ratio of positive to negative words used during episodes one and two was also calculated, refer to Table 11.

Table 11
Ratios of Positive to Negative words by Instructors and Trainees during Episodes 1 and 2

Trainee	*Ratio Instructor Positive/Negative*	*Ratio Trainee Positive/Negative*
1	2.8:1	0.4:1
2	2.1:1	1.1:1
3	2.1:1	2.3:1
4	2.01:1	2.1:1
5	1.8:1	1.2:1
6	2.9:1	0.4:1
7	4.6:1	0.8:1
8	2.3:1	2.3:1
9	2.6:1	2.5:1
10	1.9:1	1.9:1
11	2.3:1	3.9:1
12	1.8:1	1.9:1
13	2.4:1	0.4:1
14	1.4:1	1.8:1
15	2.1:1	2.5:1
16	1.9:1	2.4:1

To investigate if the average number of words used by the instructors varied depending on whether they passed or failed the training centre, or their age, sex or education level, the data was split by these variables and the means and standard deviations for each group were calculated (refer to Appendix E). The difference scores for the word counts by the instructors were then calculated (refer to Table 12).

Table 12
Differences in Word Counts by Instructors during Episodes 1 and 2 for Trainee's Pass/Fail rates, Sex, Age and Education Levels

Variables	*Instructor Differences*
Pass/Fail	217.87
Male/Female	357.85
Younger than 30 years/**30 years and older**	285.55
High school education/ **Post-secondary education**	257.05

Note. Variables in bold had higher word counts

As shown in Table 12, instructors gave more feedback to those trainees who passed the training centre compared with those who failed. Trainees who passed received an average of 217.87 more words of feedback from instructors than those who failed. Instructors also had higher word counts with the male trainees in comparison to the female trainees with a

difference of 357.85 words. Instructors used considerably more words for the older trainees than the younger trainees with a difference of 285.55 words. Instructors had lower word counts for trainees who had a high school education, compared to those with post-secondary education. The difference was 57.05 words. To investigate if the average number of words used by the trainees varied depending on whether they passed or failed the training centre, or their age, sex or education level, the data was also split by these variables and the means and standard deviations for each group were calculated (refer to Appendix E). The difference scores for the word counts by the trainees were then calculated (refer to Table 13).

Table 13
Differences in Word Counts by Trainees during Episodes 1 and 2 for Trainee's Pass/Fail rates, Sex, Age and Education Levels

Variables	*Trainee Differences*
Pass/Fail	80.57
Male/**Female**	50.82
Younger than 30 years/**30 years and older**	127.19
High school education/ **Post-secondary education**	0.77

Note. Variables in bold had higher word counts

Trainees who passed also used more words than trainees who failed, although the difference between the two groups was smaller, at 80.57 words. The difference between the trainee's word counts was not large, for males and females only 50.82 words. The older trainees offered more words, with 127.2 more words being used by older trainees than younger trainees. There was no difference between the trainee's word counts for trainees who had a high school education or post-secondary education.

The means and standard deviations were also calculated for the same variables for the ratios of positive to negative words by instructors (refer to Appendix F). The difference scores for the ratios of positive to negative words by the instructors were then calculated (refer to Table 14).

Table 14

Differences in Ratios of Positive to Negative words by Instructors during Episodes 1 and 2 for Trainee's Pass/Fail rates, Sex, Age and Education Levels

Variables	*Instructor Differences*
Pass/Fail	0.11:1
Male/Female	0.58:1
Younger than 30 years/**30 years and older**	0.56:1
High school Education/ **Post- Secondary Education**	0.07:1

Note. Variables in bold had higher ratios of positive to negative words

As shown in Table 14, the ratio of positive to negative words by the instructors was not considerably different for trainees who passed and trainees who failed, with a difference of 0.11:1. There was a difference in the ratio by the instructors to males and females, of 0.58:1. Instructors had higher positive to negative ratios for males compared to females. For younger trainees the ratio by the instructor was lower compared to the ratio for the older trainees, the difference was 0.56:1. There was not a great difference in the ratio by the instructor for trainees with a high school education and those with post-secondary education, 0.07:1. The means and standard deviations were also calculated for the same variables for the ratios of positive to negative words by trainees (refer to Appendix F). The difference scores for the ratios of positive to negative words by the trainees were then calculated (refer to Table 15).

Table 15

Differences in Ratios of Positive to Negative words by Trainees during Episodes 1 and 2 for Trainee's Pass/Fail rates, Sex, Age and Education Levels

Variables	*Trainee Means and SD*
Pass/**Fail**	0.54:1
Male/**Female**	0.49:1
Younger than 30 years/30 years and older	0.05:1
High school education/Post-secondary Education	0.84:1

Note. Variables in bold had higher ratios of positive to negative words

Trainees who passed had lower ratios of positive to negative words, compared to those who failed the difference was 0.54:1. Males had higher ratios than females with a difference of 0.49:1. The difference in the ratios by the younger and older trainees was

minimal with younger trainees having a slightly higher ratio than older trainees. Trainees with a high school education had a higher ratio of positive to negative words compared to post-secondary educated trainees with a difference of 0.84:1.

3.4 Discussion

This study examined the relationship between the demographic characteristics of trainees and their pass or failure rates during the training centre at Airways. The study also explored whether the trainees demographic characteristics had an impact on the word counts and ratios of positive to negative words, instructors gave trainees, during their debriefs after the simulation training at Airways. It also investigated if these demographics affected the word counts and ratios of positive to negative words of the trainees themselves when given this feedback. For this study, both the average word counts of trainees and instructors and the ratio of positive to negative words for trainees and instructors were examined. The word counts and the positive to negative word ratios provide a proxy of the level of explanation provided by the instructors as well as providing some insight into the interaction between the trainee and instructor,.

This study investigated if trainees' outcomes (pass/fail) were affected by demographic characteristics of age, sex and education level. No significant results were found for age or sex. However, significant results were found for education level. The study found that trainees with post-secondary education had significantly higher pass rates than trainees with a high school education. All four trainees who failed the training centre were high school educated. This demographic appears to have affected the trainee's success at the training centre. There were two other trainees with a high school education who passed, so only 33.3% of trainees with a high school education passed the training centre. 100% of trainees who had a post-secondary education passed the training centre. This result indicates that the

trainees with post-secondary education perform significantly better than trainees with a high school education. Therefore, the education level of a trainee is an important demographic to consider when selecting trainees for ATC. The reason for this significant result for post-secondary education may be that it is a screener for intelligence. Schmidt and Hunter (1998) stated that intelligence is the major determinant for job performance, therefore hiring people based on their intelligence leads to improved job performance. Given that organizations can legally screen potential trainees based on their education level, this could have important implications for the ATC community. For example, the ATC training community could investigate more closely the influence education has on trainee success and potentially consider increasing the education requirements for potential controllers

The second part of this study investigated whether these same demographics impacted the word counts and ratios of positive to negative words shared between instructor and trainee during their performance feedback sessions (debriefs). It was hypothesized that trainees above 30 years of age (older) would have different word counts and ratios in response to their feedback than trainees below 30 years of age (younger). This was found to be true for the word counts as the older trainees had much higher word counts than their younger counterparts. The older students may have had more to say in response to their feedback because they were questioning the feedback or were arguing with it. Equally, they may have been more confident engaging with their instructors. This finding does not necessarily affirm the theory put forth by Wild-Wall, Willemssen and Falkenstein (2008) that older trainees are not as receptive to feedback as the younger trainees. This finding needs further research to investigate why older trainees have higher word counts compared to younger trainees. It is also important to note that the instructors had higher word counts to the older trainees also, thus, causality cannot be inferred here. The ratio of positive to negative words was very similar for both the older trainees and the younger trainees, therefore this finding did not

support the hypothesis that the ratios of positive to negative words would differ for younger and older trainees.

Additionally, in this study, no older trainees failed, only the younger trainees did. This does not support research by Wild-Wall, Willemssen, and Falkenstein (2008) which found that older participants had a reduced ability to use feedback information for improving on a task. There are potentially other variables which were not identified in this study which may have affected the performance of older participants in Wild-Wall, Willemssen and Falkenstein's research (2008). Future research should obtain further demographic and social information, such as personality characteristics (Krasman, 2010) about the trainees. Future research would also need a much larger participant pool.

It was hypothesised that the word counts would be higher for trainees with post secondary education than for high school educated trainees and ratios of positive to negative words would also differ between the two education levels. It was not hypothesised how the ratios would differ, just that they would differ. The word counts for post-secondary educated trainees did not differ from the word counts for high school educated trainees. This finding does not support research by Verschaffel et al. (2006) that people with higher education would have been encouraged in that learning environment to share and debate their ideas and learning to a greater extent than people with high school education. However, the minimum age for beginning controller training at Airways is 20 therefore; all trainees with high school education would have done something in the time between finishing high school and beginning controller training. For example, they may have worked or travelled and these experiences may have taught them to share and debate their ideas more freely than if they had trained immediately post high school. This finding needs further investigation. Future research should collect more data on the controller trainees about their work experience and life experiences. Having such demographic information would provide a more complete

understanding of who the controller trainees are and which life experiences help or hinder them in training.

Another hypothesis for this study was that male trainees would have higher word counts and better ratios of positive to negative words than female trainees. It was found that male trainees did have higher word counts than the female trainees. This finding was supported by existing research by Tannen (1990) who found that adult men talk more in meetings, in the classroom, and in mixed-group discussions than do adult women. However, the ratios of positive to negative words for the female trainees were slightly higher than males when conversing with the instructors during their debriefs. This finding did not support the hypothesis. Deci et al., (1985) that there was a tendency for positive verbal feedback to have a more detrimental effect on females' intrinsic motivation and self-determination than males. This research corresponds with the outcomes in this study, with two females and two males failing the training centre. There were more males than females in this study, therefore females had a failure rate of 30% and males a 20% failure rate. These percentages are not drastically different. However, they demonstrate that even though females had higher ratios of positive to negative words in their feedback, it did not enhance their motivation and self-determination, as suggested by Deci et al. (1985) and this may have affected their performance. This finding needs further research to investigate if more positive feedback affects female motivation and self-determination and subsequently their performance during training. If this does occur, perhaps the ATC community would need to re-assess the ratios of positive to negative words used during any feedback with female controller trainees.

The final hypothesis for this study was that instructors' feedback would differ as a function of the trainees' demographics. This was supported by both the word counts and ratios, for the demographic age. Instructors had much higher word counts with the older trainees than the younger trainees. However, the older trainees also had higher word counts,

than the younger trainees. Therefore, there is a problem with causality here; which caused which? The ratios of positive to negative words by the instructors for the older trainees were much higher than the ratios for younger trainees. Although, the instructors may not believe they treat the older trainees any differently to the younger trainees, they. As Herold et al. (2003) have found, instructors may adjust their feedback based on assessments of the trainees. The instructors gave more positive feedback for each negative utterance to the older trainees than they did for the younger trainees. Perhaps, without even realising it, the instructors were giving more positive feedback to the older trainees to counteract the industry wide belief that older trainees have a higher likelihood of failing controller training. Whether this was detrimental or beneficial to the older trainees is unknown. At least in this study it did not seem to make a difference to the failure rates as none of the older trainees failed the training period.

This hypothesis was also supported for education level of trainees. Instructors used far fewer words for the trainees who had a high school education than for trainees who had a post-secondary education. However the trainees' word counts were quite similar across both groups. Perhaps instructors were giving more feedback to trainees with post-secondary education because consciously or not they believed they could cope with more information. Alternatively, the instructors may have perceived trainees with post secondary education as having more potential and therefore being worthy of more effort. This would be in line with the international education requirements of controller trainees (Cavcar & Cavcar, 1996). Several of the instructors trained overseas and this would align with research conducted by Herold et al., (2003) which found that teachers sometimes adjust their feedback based on personal judgements of students. This finding needs further research to assess if instructors were aware of this difference, and if so, why the amount of feedback they gave differed as a result of the trainee's education level.

Finally, the hypothesis that instructors' feedback would differ for males and females was also supported. Instructors had higher word counts for male trainees than for the female trainees. The instructors also had higher positive to negative ratios for the male trainees compared to the female trainees. ATC is a male dominated occupation, therefore as suggested by Herold et al., (2003) instructors could be adjusting their feedback based on personal judgements of the trainees. Knowing that the occupation is dominated by men, the instructors knowingly or not could be giving less feedback which was more negative to the female trainees in comparison to the feedback they provide the male trainees, to prepare them for the male dominated environment they would work in. There is a belief among many controllers that ATC is very much the skilled craftsman's club and secret knowledge, you've either got it or you haven't' (Owen, 2009, pp. 485). Perhaps the instructors' perception, based on the heavy male dominance in the profession, is that females are not naturally part of the 'skilled craftsman's club'. This finding needs more research to investigate the 'beliefs' of instructors and how pervasive their beliefs are when instructing controller trainees.

3.4.1 Implications

The finding that trainees with post-secondary education have significantly higher pass rates than trainees with a high school education could have considerable implications for the ATC community. There is real interest in the ATC community in education levels, with both the USA and France imposing strict University education requirements for potential trainees (Morrison et al., 1996, Cavcar & Cavcar, 2009). Additionally, University Entrance requirements in New Zealand have recently been increased (NZQA, 2010). Currently, New Zealand ATC requirements for education are to have completed NCEA Level 2, (this requires trainees to have completed Year 12 at high school there is a Year 13 at high school in New Zealand). However, potential New Zealand trainees must wait until they are 20 to be eligible

to begin training. This often means that trainees have three years from the time they achieve NCEA Level 2 until they can begin their controller training. In three years, those trainees could receive an Undergraduate University Degree and based on the findings in this study, they would then be more likely to succeed during their controller training. Screening for education level during the selection process is legal and has support from this study. Therefore, this finding deserves further consideration and research by the ATC community.

Future research could focus on what kind of education is most predictive of success during controller training. Additionally investigating if there is a relationship between last education experience and success during controller training would provide a comprehensive understanding of how education level relates to success during controller training.

Feedback is an important part of training and learning in the workplace, as it helps to increase people's learning and knowledge of results (Belschak & Hartog, 2008). The finding that there were no clear differences in the ratios of positive to negative words used by both younger and older trainees in relation to the hypothesis (that older trainees would have different word counts and ratios to younger trainees) may have important implications for the ATC community. Although, older trainees did have higher word counts, their instructors also had higher word counts so perhaps the older trainees just had more to say during these episodes. Perhaps for older trainees the distance from education is greater compared to younger trainees who are routinely expected to listen to their teachers and lecturers with little scope for discussion. However, in the workforce, tasks and issues are discussed at length among employees. Therefore, if older trainees had not received formal education for some time, they may naturally expect that they are able to contribute freely during their debriefs. Even though the older trainees may have had more to say, their ratio of positive to negative words was no different to the ratio of younger trainees. Additionally, none of the older trainees failed the training centre which contradicts the trend Airways have found that older

trainees having higher failure rates than the younger trainee's[6].This indicates that perhaps a person's ability to receive feedback in a constructive manner is not entirely related to age. Instead the ability to receive feedback in a constructive manner may be related to personality characteristics. Ashford and Cummings (1983) introduced the concept of feedback-seeking behaviour over 25 years ago and other researchers have since used this concept to understand the relationship between personality and feedback-seeking behaviour. In a study conducted by Krasman (2010) investigating the influence of the Big 5[7] on feedback-seeking behaviour, the results indicated that a person's feedback-seeking behaviour is partly attributable to their personality. Future research should investigate how personality impacts the way trainees receive feedback. If Airways do not already do so, they could introduce personality tests into the selection process to ensure that they select individuals who are feedback-seeking, to train as controllers.

This study also found that instructor's feedback differed as a function of the trainees' age. Instructors gave more feedback to older trainees and they had higher positive to negative word ratios for the older trainees also. Older trainees also had higher word counts themselves, therefore the finding that the instructors had higher word counts with the older trainees may just be an interaction. However, the difference in ratios of positive to negative words by the instructors to older and younger trainees may have implications for the ATC community. Perhaps instructors need to be aware of these differences and make a concerted effort to ensure that their feedback differs not only because of a trainees' age but because of their individual needs as a trainee in the training centre. The ATC community generally discourages older trainees, however this study does not support there being a difference in training success for those older or younger than 30.

[6] The sample size for this study is only 16, therefore future research with a larger sample size is required.
[7] The Big 5 are five broad domains of personality which are used to describe human personality, they are openness, conscientiousness, extraversion, agreeableness, and neuroticism (Krasman, 2010).

The final finding for this study was that education level had an impact on the type of feedback trainees were provided as well as the manner in which they received the feedback. Additionally, only trainees with high school educations failed the training centre, all trainees with post-secondary education' passed. Currently the education requirements for ATC in New Zealand is a Level 2 NCEA pass (12 credits pass in Maths at Level 1 and 8 credits in English at Level 2) and 42 other credits at Level 3 or equivalent (Airways, 2010). For many prospective controllers overseas, the education requirements are much more stringent. For example, in France, trainees begin their ATC training after completing an associate degree specifically designed to prepare them for the training and work of an ATC (Cavcar & Cavcar, 2009). Future research is needed to support the findings that there were higher failure rates by high school educated trainees than there were by post-secondary educated trainees and that the education levels impacted the type of feedback given and the way it was received. Additionally, the ATC community in New Zealand may need to revisit their educational prerequisites for controllers and raise the minimum educational requirements to align with overseas standards. Doing this may well decrease the failure rates at the training centre.

3.4.2 Limitations

This study is associated with a number of limitations. The most significant limitation was the manner in which the data was collected. Additionally, the four trainees who failed the training centre failed at different times during this study and some trainees were sick or missed days when they were supposed to complete some simulation training. Therefore, there was a range for all trainees in the number of episodes collected. Because of this range only two episodes were able to be analysed in this study. Future research would benefit from having the same number of complete recordings for each trainee to allow thorough analysis of each trainee's progress at the training centre.

A further limitation was that the quality of the recordings was quite poor at times. Although, the equipment used to record the episodes was good it did not have a big enough range to record the conversations between two people who were often sitting quite far apart. Many of the debriefs took place in the simulators where the instructor and trainee could be sitting quite far apart from each other. Also whilst in the simulators, they were competing with a lot of background noise from the projectors in the simulators. Future research would benefit from having small microphones on the clothing of both the instructor and trainee, to ensure their conversation is clearly audible. Also, if all debriefs took place in the debriefing rooms and not in the simulators, the background noise would be significantly reduced and the recording quality greatly enhanced.

Another limitation was the sample size for this study. The sample size was restricted by Airways training centre because they only have classes of 15 trainees and they only have a few classes each year. Future research, would benefit from analysing several classes over a period of a several years, this would increase the sample size and allow for more rigorous analysis of the debriefs during the training period. In addition, analysing more components of the debrief may benefit future research. This study only investigated word counts and ratios of positive to negative words. Future research could gain better insight by investigating specific words, and time lapses between instructor and trainee during the debrief session.

In conclusion, this study investigated whether the demographic characteristics of trainees had an impact on the kind of feedback instructors gave trainees during their debriefs after the simulation training at Airways. It also investigated if these demographics affected the word counts and ratios of positive to negative words of the trainees in response to this feedback. Hypothesis one, that older trainees would have different word counts and ratios in response to the feedback they received compared to the younger trainees, was partially supported. The word counts of older trainees in response to their feedback were higher

compare to their younger counterparts however, the ratios of positive to negative words did not support this hypothesis. Hypothesis two which stated that the instructor's feedback would differ as a function of the trainee's age was supported by both the word counts and the ratios. Finally, the third hypothesis that the sex and education level of trainees would impact their outcome during training was also supported.

Chapter 4: General Discussion

The present research comprised two studies exploring the effect of demographic characteristics on training outcomes. The first study investigated the relationship between pass/fail rates during a training period and demographics of age, sex and education level from a data set of 159 trainees. The second study, with a much smaller data set of 16 trainees investigated the impact these demographics have on the outcome for trainees as well as the feedback given and received in a training centre.

The first study showed that as hypothesised, older trainees had higher failure rates than younger trainees. This study also found that the education level of trainees plays a role in trainees' training outcomes. Exploring the age, sex, education levels and outcomes of trainees' training, it was found that there were certain demographic combinations which were better suited to the ATC training than other combinations. For example young, females with post-secondary education were found to be the most successful group of trainees. Additionally, there were different stages of the training to which some combinations were better suited. Young females with post secondary education only failed in training, whereas young males with post-secondary education had more failures in the field than they did at the training centre. This study should assist the ATC community to streamline their recruitment and training of controllers to maximise their return on investment. The ATC training community have a variety of options. Firstly, they could change their recruitment processes

to target those trainees most suited to the training to become controllers. Secondly, they could change some of their education requirements for potential trainees. Thirdly they could invest more into their trainees once they have begun the training by differentiating their teaching to the learning needs of the trainees (NZC, 2010). For example, ATC training facilities could tailor the simulations more to the individual trainees. Alternatively, they could put some simulations on desk-top computers and allow the trainees to complete some simulations individually. As the results have shown, some trainees will pass the training centre and then struggle or ultimately fail in the field, while other trainees who may have done really well in the field never make it there because they struggle with the training centre. If ATC training facilities can identify the training needs of their trainee and give them appropriate guidance, they would be able to increase the number of trainees succeeding. Of course ATC training facilities would have to complete a cost benefit analysis to determine if investing further time and money into the trainees at the training centre and in the field would be valuable or not.

The finding that the education level of trainees plays a role in their outcome during controller training was further investigated in Study 2. It was found in Study 2 that trainees with post-secondary education had significantly higher pass rates than trainees with a high school education. Neither age nor sex were significant. The statistically significant findings in Study 2 confirm the trends found in Study 1. The reason for significant results in Study 2 and not in Study 1 could be that the data set in Study 1 was incomplete. For example, only 19.8% of the sample in Study 1 had a high school only education, but 37.5% of Study 2 had only a high school education; perhaps the missing data in Study 1 included more high school only people and many of which failed. Alternatively, Study 1 included past and present trainees and Study 2 included trainees from only 2010, so it may have something to do with ATC becoming more technical or the training itself becoming more technical. For example, the simulator based training has only been running for a few years.

This finding aligns with industry standards overseas which require prospective controllers to have under-graduate degrees specifically designed to prepare trainees for ATC training (FAA, 2010).

4.1. Conclusion

The results of both studies show that there are certainly some changes the ATC community in New Zealand could make to their training processes going forward. The significant finding that education level affects the outcomes of trainees needs to be further investigated and addressed by the ATC community. In particular they may wish to review their education requirements to align with the changing University Entrance requirements in New Zealand (NZQA, 2010) as well as International industry standards (Cavcar & Cavcar, 2009). Some of the proposed changes will take time and cost more to implement, but the long term benefits will surpass all of this. For example, saving an average of $11,666 per failure during the training centre or a minimum of $51,380 per failure during training in the field would be a considerable saving for an organization like Airways. If the ATC community invest in these changes they will ensure that they select the appropriate trainees to train as controllers as well as providing the appropriate learning and support for those trainees to ensure they are successful during each component of their training. Doing this may assist the worldwide shortage of controllers (French, 2009) as well as guaranteeing that we are in the safest hands every time we travel by air.

References

Airways (2010). *Trainee Air Traffic Control Careers.* Retrieved from http://www.airways.co.nz/careers/atc_careers.asp

Ashford, S. J., & Cummings, L. L. (1983). Feedback as an individual resource: Personal strategies of creating information. *Organizational Behaviour and Human Performance*, 32, 370-398.

Belschak, F. D., & Den Hartog, D. N. (2009). Consequences of Positive and Negative Feedback: The impact on Emotions and Extra-Role Behaviours. *Applied Psychology*, 58(2), 274-303.

CAST. (1999). *Consequences of future ATM systems for Air Traffic Controller Selection and Training.* (Work Package Nº3 Future Selection and Training Requirements). Brussels: European Commission DG VII.

Cavcar, A. & Cavcar, M. (2009). New Directions for ATC Training: A Discussion. *International Journal of Aviation Psychology,* 14(2), 135-150.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behaviour*. New York: Plenum Press

Education that works. (2010). *Nontraditional Career Options*. Retrieved from http://www.sunyscc.edu/trainee/nco.htm

Federal Aviation Administration. (n.d). *How to become an Air Traffic Controller.* Retrieved from

http://www.faa.gov/about/office_org/headquarters_offices/ahr/jobs_careers/occupations/atc/path3/

Fredickson, B. L. & Losada, M. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist*, 60(7), 678-686.

French, P. (2009). *Air Traffic Out of Control?* Retrieved from http://www.airport-technology.com/jobs/career/out-of-control.html

Gigerenzer, G. & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review*, 103(4), 650–669.

Goodman, J. S. (1998). The interactive effects of task and external feedback on practice performance and learning. *Organizational Behaviour and Human Decision Processes,* 76, 223-252

Greller, M. M., & Simpson, P. (1999). In search of late career: A review of contemporary social science research applicable to the understanding of late career. *Human Resource Management Review, 9,* 309-347.

Herold, D. M., & Fedor, D. B. (1998). Individuals' interaction with their feedback environment: The role of domain-specific individual differences. In G. Ferris (Eds.), *Research in personnel and human resources management* (pp. 215–254). Greenwich, CT: JAI Press.

Herold, D. M., & Fedor, D. B. (2003). Individual differences in feedback propensities and training performance. *Human Resource Management Review,* 13, 675-689.

Institute for Higher Education Policy. (1998). *Reaping the Benefits.* Retrieved from http://www.ihep.org/press-room/news_release-detail.cfm?id=135

Krasman, J. (2010). The Feedback-Seeking Personality: Big Five and Feedback-Seeking Behaviour. *Journal of Leadership and Organizational Studies*, 17(1), 18-32.

Markus, K. A. (2001). The Converse Inequality Argument against Tests of Statistical Significance. *Psychological Methods,* 6(2), 147-160.

Morrison, J.E., Fotouhi, C.H. & Broach, D. (1996). *A formative evaluation of the collegiate training initiative- air traffic control specialist (CTI-ATCS) program*. Washington, DC: Office of Aviation Medicine.

Net Industries. (2011). *Stress and Coping – Coping Responses* Retrieved from http://medicine.jrank.org/pages/1667/Stress-Coping-Coping-responses.html

Neuendorf, K. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

New Zealand Curriculum Online. (2010). Retrieved from http://nzcurriculum.tki.org.nz/

NZQA. (2010). *Proposed changes to the university entrance (UE) requirement.* Retrieved From http://www.nzqa.govt.nz/about-us/consultations-and-reviews/proposed-changes-to-the-university-entrance-ue-requirement/

Owen, C. (2009). Instructor beliefs and their mediation of instructor strategies. Journal of Workplace Learning, 21(6), 477- 495.

Park, D. C. (1992). Applied cognitive aging research. In C. I. M. Fergus & T. A. Salthouse (Eds.), *The Handbook of Aging and Cognition* (pp. 449-493). Hillsdale, NJ: LEA.

Ree, M. J., & Earles, J. A. (1992). Intelligence is the best predictor of job performance. *Current Directions in Psychological Science*, 1, 86-89.

Resnick, L. B. (1987). The 1987 Presidential Address: Learning in School and out. *Educational Researcher*, 16 (9), 13-20**.**

Schmidt, F. L., & Hunter, J. E. (1998). The Validity and Utility of Selection Methods in Personnel Psychology: Practical and Theoretical Implications of 85 Years of Research Findings. *Psychological Bulletin,* 124(2), 262-274.

SPSS for Windows. (2005). Chicago: SPSS Inc.

Taleb, N. N. (2010). *The Black Swan: Second Edition: The Impact of the Highly Improbable* (2nd Ed.), New York, United States: Random House Trade.

Tannen, D. (1990). *You just don't understand: women and men in conversation*. New York: Ballentine Books.

Tannenbaum, S. I., & Yukl, G. (1992). Training and development in work organizations. *Annual Review of Psychology*, 43, 399–441.

The General Inquirer. (2002). *Inquirer Home Page*. Retrieved from http://www.wjh.harvard.edu/~inquirer/

The Gottman Institute. (2005). *Research.* Retrieved from http://www.gottman.com/57326/Research.html

Verschaffel, L., Dochy, F., Boekaerts, M., & Vosniadou, S. (2006). *Instructional psychology: past, present, and future trends: Sixteen essays in honour of Erik de Corte (Advances in Learning and Instruction) (Advances in Learning and Instruction Series).* Amsterdam, The Netherlands: Emerald Group Publishing.

Wild-Wall, N., Willemssen, R., & Falkenstein, M. (2008). Feedback-related processes during a time-production task in younger and older adults. *Clinical Neurophysiology,* 120, 407-413.

Appendix A

Information Sheet

Department of Psychology

You are invited to participate as a subject in the research project - The effects of age, sex and education level on Air Traffic Control training outcomes.

The aim of this project is to investigate the role demographics such as age, sex and prior education level may play during training at Airways.

Your involvement in this project will be to allow a small audio recording device to sit near you during five of your simulated training episodes. Additionally, the researcher will gain access to demographic information such as your age, sex and prior education level, all information you provide to the Airways training centre. You have the right to withdraw from the project at any time.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation: the identity of participants will not be made public without their consent. To ensure anonymity and confidentiality, I will keep all demographic information provided by Airways in a folder, stored in my desk, in a locked office. The interactions in the simulation training episodes will be recorded onto a handheld digital recorder. After each simulation, the audio files will be transferred to a personal laptop computer and backed up to an external hard drive. Files will be erased from the recorder after confirmation of successful file transfer. This will be done to minimise the risk of any sensitive data being obtained if the recording device is stolen or lost. Files will be transcribed and transcriptions will be numbered again linking them to the number which correlates with the demographic information, but not identifying the participant. All data stored electronically will only be accessible with a password known only to the researcher. As this project requires transcription services a confidentiality agreements will be made with the transcribers and participants will made aware of this.

The project is being carried out as a requirement for the Applied Psychology Course at the University of Canterbury by Alexander Dwan who can be contacted at 021847772 or 3548381. The project is under the supervision of Sanna Malinen and Deak Helton who can be contacted at **364 2987. They** will be pleased to discuss any concerns you may have about participation in the project.

The results of this thesis will be a public document via the University of Canterbury library database. This project has been reviewed ***and approved*** by the University of Canterbury Human Ethics low risk reporting process.

Appendix B

Table 16

Chi-Square Test of Age and Pass/Fail rates

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.015[a]	1	.156		
Continuity Correction[b]	1.506	1	.220		
Likelihood Ratio	1.962	1	.161		
Fisher's Exact Test				.180	.111
Linear-by-Linear Association	2.003	1	.157		
N of Valid Cases	159				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.31.

b. Computed only for a 2x2 table

Table 16 shows a non-significant relationship between the age of trainees and whether they pass or fail the training centre at Airways (p = n.s.)

Table 17

Chi-Square Test of Sex and Pass/Fail rates

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.174[a]	1	.677		
Continuity Correction[b]	.048	1	.827		
Likelihood Ratio	.172	1	.679		
Fisher's Exact Test				.694	.409
Linear-by-Linear Association	.173	1	.678		
N of Valid Cases	162				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.95.

b. Computed only for a 2x2 table

Table 17 shows a non-significant relationship between the sex of trainees and whether they pass or fail the training centre at Airways (p = n.s.

Table 18

Chi-Square Test of Education Level and Pass/Fail rates

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.155[a]	1	.142		
Continuity Correction[b]	1.553	1	.213		
Likelihood Ratio	2.053	1	.152		
Fisher's Exact Test				.182	.108
Linear-by-Linear Association	2.142	1	.143		
N of Valid Cases	162				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.69.

b. Computed only for a 2x2 table

Table 18 shows a non-significant relationship between the education level of trainees and whether they pass or fail the training centre at Airways (p = n.s)

Appendix C

Table 19

Fisher's Exact Test with independent variables, Age, Sex and Education Level and dependent variable, Stage of Failure

Education Level	Sex		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
0	0	Pearson Chi-Square	.577[a]	1	.448		
		Continuity Correction[b]	.072	1	.789		
		Likelihood Ratio	.563	1	.453		
		Fisher's Exact Test				.630	.387
		Linear-by-Linear Association	.550	1	.458		
		N of Valid Cases	22				
	1	Pearson Chi-Square	1.875[c]	2	.392		
		Likelihood Ratio	2.231	2	.328		
		Linear-by-Linear Association	.843	1	.359		
		N of Valid Cases	10				
1	0	Pearson Chi-Square	3.062[d]	2	.216		
		Likelihood Ratio	2.871	2	.238		
		Linear-by-Linear Association	.238	1	.625		
		N of Valid Cases	94				
	1	Pearson Chi-Square	5.465[e]	2	.065		
		Likelihood Ratio	5.664	2	.059		
		Linear-by-Linear Association	5.299	1	.021		
		N of Valid Cases	33				

As shown in table 17, there were no significant relationships between any of the sub-groups and the stage at which they failed during their training (p = n.s.)

Appendix D

Calculations for risk-analysis

Sub-groups:

1. Males <30 with high school education
2. Males 30+ with high school education
3. Males <30 with post-secondary education
4. Males 30+ with post-secondary education
5. Females <30 with high school education
6. Females 30+ with high school education
7. Females <30 with post-secondary education
8. Females 30+ with post-secondary education

Calculation = (Cost of failure during training x % of those who failed in sub-group 1) + (Cost of failure in the field x % of those who failed in sub-group 1) = Potential 'risk' in $ for sub-group 1. Due to the different number of trainees in each sub-group the percent of failure was multiplied by the cost of one failure, to ensure the sub-groups with larger numbers of trainees would not be over represented.

Appendix E

Table 20

Means and Standard Deviations of the Average Word Counts by Instructors and Trainees during Episodes 1 and 2

Variables	*Instructor Means and SDs*	*Trainee Means and SDs*
Pass	1025.25 (463.04)	484.67 (153.06)
Fail	807.38 (468.58)	404.1 (122.54)
Male	1062.85 (514.24)	304.6 (152.7)
Female	705 (216.98)	355.42 (131.60)
Younger than 30 years	875.12 (338.96)	299.81 (148.19)
30 years and older	1160.67 (871.23)	427 (44.37)
High school education	768 (383.12)	321.83 (105.9)
Post Sec. education	1025.05 (484.64)	322.6 (166.94)

Appendix F

Table 21

Differences in Ratios of Positive to Negative words by Instructors during Episodes 1 and 2 for Trainee's Pass/Fail rates, Sex, Age and Education Levels

Variables	*Instructor Means and SD*	*Trainee Means and SD*
Pass	2.34:1 (0.81)	1.61:1 (0.79)
Fail	2.23:1 (0.43)	2.15:1 (1.44)
Male	2.53:1 (0.80)	1.56:1 (1.15)
Female	1.95:1 (0.39)	2.05:1 (0.52)
Younger than 30 years	2.21:1 (0.37)	1.68:1 (1.03)
30 years and older	2.77:1 (1.65)	1.63:1 (0.76)
High school education	2.27:1 (0.37)	2.27:1 (1.13)
Post Sec. education	2.34:1 (0.89)	1.43:1 (0.75)