Design and Implementation of Adolescent Learning Strategies –

Can an adolescent learning strategy improve the learning experience of 17-23 year olds in a military officer training establishment such as ADFA?

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# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>iii</td>
</tr>
<tr>
<td>List of tables</td>
<td>v</td>
</tr>
<tr>
<td>Chapter 1 – Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Chapter 2 - Literature Review – Examining brain based learning, cognitive neuroscience and educational psychology</td>
<td>9</td>
</tr>
<tr>
<td>- Defining the age of the brain</td>
<td>11</td>
</tr>
<tr>
<td>- Brain function</td>
<td>14</td>
</tr>
<tr>
<td>- The ‘sensitive period’</td>
<td>20</td>
</tr>
<tr>
<td>- Left/Right brain dominance</td>
<td>21</td>
</tr>
<tr>
<td>- Gender differences and learning</td>
<td>22</td>
</tr>
<tr>
<td>- Other criticisms</td>
<td>24</td>
</tr>
<tr>
<td>- Brain ‘health’</td>
<td>25</td>
</tr>
<tr>
<td>- How people learn</td>
<td>27</td>
</tr>
<tr>
<td>- Summary</td>
<td>37</td>
</tr>
<tr>
<td>Chapter 3 – Establishing the context</td>
<td>41</td>
</tr>
<tr>
<td>- Holistic consideration</td>
<td>42</td>
</tr>
<tr>
<td>- Culture and unacceptable behaviour</td>
<td>43</td>
</tr>
<tr>
<td>- Officer Cadet training and development</td>
<td>45</td>
</tr>
<tr>
<td>- Summary</td>
<td>47</td>
</tr>
<tr>
<td>Chapter 4 - Designing an adolescent learning strategy</td>
<td>48</td>
</tr>
<tr>
<td>- Proposed Adolescent Learning Factors</td>
<td>49</td>
</tr>
<tr>
<td>- Defining the parameters of the learning environment</td>
<td>51</td>
</tr>
<tr>
<td>- Adolescent learning strategy</td>
<td>52</td>
</tr>
<tr>
<td>- Applied adolescent learning strategies</td>
<td>63</td>
</tr>
<tr>
<td>- Summary</td>
<td>64</td>
</tr>
<tr>
<td>Chapter 5 - Method of investigation</td>
<td>66</td>
</tr>
<tr>
<td>- Evaluating the suitability of available data</td>
<td>69</td>
</tr>
<tr>
<td>- Analysis of the data</td>
<td>76</td>
</tr>
<tr>
<td>- Summary</td>
<td>80</td>
</tr>
</tbody>
</table>
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List of tables


Table 2 – ADFA Generations during implementation of adolescent learning strategy 2011-2013. p 74.

Table 3 – ADFA Internal Training Review Data Sets (DS). p 75, 86.

Table 4 – ADFA ‘Population’ response rate to internal training review. p 76, 108.

Table 5 – Volume of data available. p 78, 93.

Table 6 – Comparison of Internal Training Review ‘Leadership’ Questions. p 79.

Table 7 – Qualitative analysis – Scoring Rubric. p 83, 94.

Table 8 – Measurement of Satisfaction and Engagement. p 84.

Table 9 – Academy Military Education and Training (AMET) program quantitative data results. p 88.

Table 10 – AMET Quantitative Data Results by academic year and military subject. p 89-90, 117-118.

Table 11 – Quantitative results for Leadership Studies and Military Communications. p 91, 119.

Table 12 – AMET Qualitative Data Results by academic year and rubric score. p 96.

Table 13 – Percentage of constructive comments by Year level 2011-2013. p 97, 114.

Table 14 – Percentage of non-constructive comments by year level 2011-2013. p 98, 114.

Table 15 – Percentage of neutral criticism comments by year level 2011-2013. p 99.

Table 16 – Percentage of positive experience by year level 2011-2013. p 100, 121.
Table 17 – Percentage of negative experience by year level 2011-2013. p 101, 123.

Table 18 – Percentage of neutral experience by year level 2011-2013. p 102.

Table 19 – Results of Statistical Significance Tests. p 104.

Table 20 – Effect Sizes. p 105.

Table 21 – Number of Qualitative Comments Volunteered. p 105.

Table 22 – AMET Quantitative Data Results by generation. p. 108-109.

Table 23 – ‘Generation C’ cohort analysis of quantitative results for Leadership Studies and Military Communications. p. 110.
Chapter 1 - Introduction

This thesis is a case study in educational change. It explains how an adolescent learning strategy was developed at the Australian Defence Force Academy (ADFA), in 2011-2013, and evaluates the effects of ADFA’s adolescent learning strategy on trainee engagement and trainee satisfaction.

Previous inquiries into ADFA (Broderick, 2011; Grey, 1998; Kafer, 2010) had noted a number of persistent problems, many of them behavioural problems, but also motivation and engagement problems, and dissatisfaction with ADFA’s military education program. Those inquiries either recommended explicitly, or assumed in passing, that ADFA should be organised as an adult learning environment, utilising adult learning principles such as: intrinsic motivation based on adults’ autonomy in choosing what to learn, adults’ participation in design and evaluation of their own learning programs, inclusion of adults’ own relevant life experiences in learning activities, and timely application of learning to solve real-world problems of interest to those adult learners (eg. see Knowles, 1980).

While some of these principles seemed difficult to reconcile with the hierarchy and culture of a military establishment, learners at ADFA were, for some years, given less supervision and guidance, in an attempt to foster greater autonomy and, it was hoped, intrinsic motivation. But intrinsic motivation requires autonomy in choosing what to learn and the curriculum of ADFA’s military education program is designed to meet the organisational needs of the Australian Defence Force (ADF), not the individual interests of each trainee officer.
Understandably, ADFA continued to have serious motivation and engagement problems, identified in the Kafer Review of 2010. Consequently, ADFA’s leadership began to question the suitability of adult learning principles for a military education program educating 17-23 year old officer trainees in principles and techniques required for their future military careers.

The search for an alternative approach began with a survey of relevant findings on student engagement from the field of educational psychology. It also led to another recent body of literature outlining research observations on the development of the brain in adolescence and young adulthood. Some of this literature discussed potential implications for the behaviour, reasoning and learning of adolescents and young adults. The empirical observations underpinning this research related to the 15-25 year old age demographic. The potential relevance to ADFA’s 17-23 year old demographic demanded further investigation. Both of these bodies of literature are reviewed in Chapter 2.

The alternative approach implemented at ADFA was based on both bodies of literature – educational psychology’s findings on student engagement and cognitive neuroscience’s still-tentative findings on adolescent brain development and the potential implications for adolescent learning. The approach has been termed an ‘adolescent learning strategy’ or ‘adolescent learning environment’. It is founded on the prevailing constructivist model of learning from educational psychology, but modified in small, yet potentially important, ways according to the research on adolescent brain development.

ADFA’s adolescent learning strategy was implemented progressively in 2011-2013. The purpose of this thesis is to explain how ADFA’s adolescent learning strategy was designed to be
consistent with findings in both bodies of research literature and to evaluate its effects on trainee engagement and satisfaction with ADFA’s military education program.

The thesis investigates whether (and why) an adolescent learning strategy might improve the learning experience of 17-23 year old learners in an establishment such as ADFA, and two specific research questions are addressed empirically, using data collected during the implementation period:

1. Did implementation of ADFA’s adolescent learning strategy improve trainee engagement between 2011 and 2013?
2. Did implementation of ADFA’s adolescent learning strategy improve trainee satisfaction between 2011 and 2013?

The organisational context for this case study is ADFA. ADFA is a military training establishment that contributes to the training of officers for the Royal Australian Navy (RAN), the Australian Army and the Royal Australian Air Force (RAAF). Although there are many different pathways to becoming an officer, this research focuses on ADFA’s undergraduate program for ab initio officer trainees. The complete officer training continuum for ab initio trainees includes additional periods of instruction conducted by each of the parent services, Navy, Army and Air Force. However, ADFA’s role within this continuum is to provide: a balanced liberal tertiary education in conjunction with the military training required to operate effectively within the ADF environment; the opportunity for networking within a tri-service setting, and; leadership and character development. The balanced liberal tertiary education at ADFA is provided by the University of New South Wales, under a long-term contract with Defence. The military training at ADFA is provided by ADF Instructors in the Academy Military
Education and Training (AMET) Program. It is the military education in the AMET Program that is the focus of this case study.

Navy Midshipmen arrive at ADFA having already completed Naval training at HMAS Creswell followed by an additional six months of work experience within the Fleet. By comparison, Army and Air Force Officer Cadets generally arrive at ADFA immediately after completing their high school education, and then unlike the Navy, complete additional service specific training at Royal Military College – Duntroon for Army, or Officer Training School East Sale for Air Force. Accordingly the age demographic at ADFA is approximately 17-23 years of age.

In the 30 year history from when ADFA opened in 1986 until the time this thesis was written in 2016, the Australian Defence Force Academy undergraduate program has successfully graduated 6337 personnel and maintained the highest completion rate of any university within Australia. Unfortunately these results are not the only aspects of ADFA’s reputation that are widely known or reported. Throughout the relatively short operation of ADFA there have been several behavioural incidents that have resulted in significant media coverage and formal reviews into not only ADFA, but in some instances the whole ADF. These reviews have focused on aspects of behaviour, culture, organisation, discipline, alcohol use, social media, and treatment of women, amongst others, and have all made recommendations for improvements within ADFA.

One debate running through these reports has focused on the appropriate learning environment for ADFA. This study contributes to that debate. Earlier contributions have, for
the most part, been based on principle or on the author’s own preference. This contribution, in contrast, is based on the research literature reviewed and the data analysed in the thesis.

One of the most significant recommendations that had shaped ADFA’s approach to the education and training of Midshipmen and Officer Cadets had been to recognise the trainees as adults due to their legal status and the future responsibilities expected of them as fully trained officers, and accordingly to foster an adult learning environment. However, despite the many reviews and the application of an adult learning environment, ADFA continued to have motivational issues that were identified in the Kafer Review of 2010, and behavioural problems that were highlighted again in the so called ‘Skype scandal’ of 2011, when two trainees broadcasted a consensual sexual encounter to five of their colleagues.

In 2011, ADFA began to question the utility of adult learning environments for the 17-23 year old demographic, believing that the trainees were using the freedoms associated with being treated like adults to behave in an undisciplined and inappropriate manner because they may have lacked the maturity and life experience to know any better. The aim of this thesis is to explain the changes that were made to ADFA’s learning environment, using research from adolescent brain development and educational psychology, and to evaluate those changes using data collected during the three year implementation period.

Chapter 2 conducts a review of literature on brain-based learning, cognitive brain function, brain development, and educational psychology. This review identifies that the early 1990s produced a raft of brain-based educational models such as the Sensitive Period, Left/Right Dominance, and Gender based learning; however, many of them were based on unfounded
inferences from relatively immature research. Recent medical advances and more detailed research has suggested that adolescent brains do function and process information differently when compared with children and adults. This chapter also conducts a review of educational psychology that suggests adolescents value short term extrinsic rewards and peer status in contrast to adults who are often more intrinsically motivated. Chapter 2 explains why a bespoke pedagogy may benefit adolescent learning more than the application of an adult learning environment.

In Chapter 3 the research conducts a holistic theme based consideration of some of the key formal reviews that have been conducted at ADFA to provide context and develop an understanding of ADFA’s learning strategy over time. This chapter considers whether the recommendations that have been made by these formal reviews are consistent with the emerging knowledge about adolescent brain function. Most notably, this chapter identifies that the application of an adult learning strategy at ADFA did not seem to address the problems in relation to motivation and unacceptable behaviour. This chapter proposes that the continuation of these problems may be related to the inconsistency of adult learning strategies with what Chapter 2 established in relation to adolescent brain function and motivation, and provides justification for why an adolescent learning strategy was designed and implemented.

Chapter 4 explains in more detail why an adult learning environment is likely to be unsuccessful with ADFA’s demographic and then uses the adolescent learning factors derived in Chapter 2 to develop a series of specific changes which comprise ADFA’s adolescent learning strategy.
Chapter 5 proposes the method used to address the two specific research questions about the effects of an adolescent learning strategy on trainee engagement and satisfaction. Throughout the 2011-2013 period, ADFA conducted a bi-annual internal trainee survey to evaluate the Academy Military Education and Training (AMET) program. This survey produced quantitative responses to close-ended questions and qualitative responses to open-ended questions. Although highlighting some limitations, this chapter determines that the available data provided by the trainee surveys is suitable for secondary, pre-post comparison in order to answer the two research questions.

Chapter 6 presents the results of the pre-post comparison using the quantitative and qualitative data from the internal trainee review process that was conducted with all three year levels every six months. The quantitative data presents the percentage of trainees who reported a positive learning experience in a Likert Scale in relation to questions about each military subject. The qualitative data required the examination of 7561 individual written comments in response to open-ended questions. These individual comments were rated against a scoring rubric that was designed to measure engagement and satisfaction. Longitudinal data are displayed graphically to present the apparent trends in student satisfaction and student engagement throughout the 2011-2013 implementation period. Aggregated data from 2011 and 2013 are used to conduct a pre-test/post-test statistical analysis of the changes in student satisfaction and student engagement.

The final discussion chapter considers the results presented in Chapter 6 and applies them to the two specific research questions. Chapter 7 discusses the results against four elements of the learning experience: trainee engagement, trainee satisfaction, quality of instruction and demonstrated achievement of the learning objective. This chapter acknowledges that some
limitations in the data and the method of analysis applied have resulted in it being impossible to prove a causal relationship between the application of an adolescent learning strategy and a positive impact on trainee engagement and satisfaction. Although it is impossible to prove causation with the method used here, the statistical results provide clear evidence that trainee engagement and satisfaction did improve markedly when an adolescent learning strategy was implemented.
Chapter 2 - Literature Review – Examining brain based learning, cognitive neuroscience and educational psychology

The search for a more suitable learning strategy, or learning environment, was motivated by persistent problems of trainee disengagement and dissatisfaction with ADFA’s military education program. The challenge was to improve trainee engagement and satisfaction.

The study of learning environments and their effects on learners and learning is one important focus of the discipline of educational psychology. Many of its disciplinary findings are, by now, well established, so educational psychology had a clear role to play in guiding the redesign of ADFA’s learning environment. However, another related body of emerging research literature has recently been proposing some intriguing new ideas about specific ways in which 15-25 year olds might differ from adults and children in their reasoning, risk taking, sensitivity to peers, sensitivity to stress and response to rewards – all of which can be important factors in a learning environment. This body of literature comes from cognitive neuroscience and it focuses on the characteristics and development of the brain and its behavioural correlates, during adolescence.

Both of these bodies of literature will be reviewed, in this chapter, but since the adolescent brain studies are so new and, perhaps, less familiar, more time will be spent describing them and explaining their potential implications for learning environments. It must also be acknowledged, quite frankly, that ‘brain-based learning’ is an idea which has earned a dubious reputation. This is due to over-enthusiastic adoption of some simplistic ideas emanating from the more speculative early days of brain research (eg. left-brain vs right-brain dominance).
Some of those premature ideas, now mostly discredited, will be discussed briefly, to differentiate them from the more recent, empirically-supported findings that inform this study.

Since the 1990’s there have been unprecedented advancements in the field of cognitive neuroscience (Blakemore, 2012). Technological developments such as functional Near-Infrared Spectroscopy (fNIRS), Magnetic Resonance Imaging (MRI) and functional MRI (fMRI) have enabled the investigation of brain structure, function and development in a manner that was previously unachievable from studying post-mortem human brains (Blakemore, 2012). These new technologies have enabled neuroscientists to map the physical development of the brain as it continues to evolve from childhood through adolescence and into adulthood. Brain scan technology has also provided the opportunity to examine which parts of the brain are functioning whilst people are performing different tasks, and has shown that these areas of the brain function differently in children, adolescents and adults when conducting the same tasks. The findings of neuro-scientific research into brain development and function, have excited many within the educational profession who have made inferences from the findings in order to develop educational techniques that accommodate how the brain operates. The educational techniques that have been developed on the basis of the emerging field of cognitive neuro-science are often referred to as ‘brain based education’ (Bruer, 1999), or ‘brain based learning’.

As brain based learning has gained traction and become increasingly popular in educational circles it has spawned a number of books, journals and educational products aimed at every age group from babies in utero, to early childhood, teenagers and adults (Jorgenson, 2003). However, there is significant debate on the validity of brain based education. Advocates for
the brain based educational approach have come under considerable criticism by others who claim that cognitive neuroscience and brain imagery has failed to ‘prove’ the link between brain development, brain function, behaviour and learning. Such critics insist that the best learning techniques have been developed through educational psychology, not biology (Bruer, 1999).

This review will consider both sides of the debate regarding brain based learning. My intention is to determine whether the emerging field of cognitive neuroscience can provide an evidentiary case supporting the development of a tailored pedagogical approach for students within ADFA.

**Defining the ‘age’ of the brain**

Most of the Midshipmen and Officer Cadets attending ADFA are between the ages of 17 and 23 (Broderick, 2011). Accordingly, before considering the merits of a brain based pedagogical approach, it will be important to determine whether there is something common about the brain function of 17 to 23 year olds. This 17 to 23 age demographic spans a very difficult period to accurately define. Under Australian law the legal age of majority is 18 and accordingly, each Midshipmen or Officer Cadet that has reached this age is legally an adult, while those that have yet to reach the age of 18 are still considered minors or children. Those that are 17-19 are also referred to as ‘teenagers’, a relatively new term that entered common usage after World War 2 (Sawyer, Afifi, Bearinger, Blakemore, Dick, Ezeh, and Patton, 2012). The World Health Organisation (WHO) has also categorised those between 10 and 19 as ‘adolescents’, a term generally used to describe the period of physical development that occurs from the onset of puberty through to sexual maturity. Increasingly however, the WHO is using the term
‘Youth’ to refer to the environmental and behavioural similarities of those in the age category 15 to 24 (Sawyer, Afifi, Bearinger, Blakemore, Dick, Ezeh, and Patton, 2012). From the perspective of ADFA, each of these terms could be used to categorise the demographic of Midshipmen and Officer Cadets differently. However, for the purpose of this research project it is important to consider whether there is something about the age demographic that makes them similar, not legally or physically, but cognitively.

With the use of MRI technology, neuroscientists have been able to establish some clearly identifiable characteristics of physical brain development. The brain first starts to develop three weeks into gestation and the growth of neurons, and synapses connecting the neurons, continues at a very rapid rate (Wolfe, 2010). By halfway through the pregnancy, all of the major functional areas of the brain are present in an underdeveloped state. By the ninth month of gestation the brain has commenced a process called myelination. Myelination occurs when a glial cell wraps Myelin around an axon (part of the neuron that sends information), allowing faster transmission of messages between neurons. It is the light colour of Myelin that results in parts of the brain being referred to as ‘white matter’. Prior to a cell being myelinated it does not function at maximum potential. Although myelination commences at the ninth month of gestation, at this early stage it only occurs in areas of the brain associated with primary function such as sight (Wolfe, 2010).

As the brain continues to grow and develop, the process of ‘pruning’ excess synapses commences at two years of age in order to make the brain more efficient (Wolfe, 2010). The synapses that are used regularly are strengthened, and those that are not are pruned. During this period of brain development it is very important that the brain is not deprived of normal environmental inputs. For example, if a child is born with cataracts that are not removed early,
the opportunity for the development of sight is severely limited (Wolfe, 2010). Normative emotional input is equally important at this stage of development. Studies of Romanian orphans have demonstrated that a lack of early emotional attachment at a young age can impact the ability to develop normal emotional relationships later in life (Wolfe, 2010).

Sections of the brain that have relatively few myelinated cells are referred to as ‘grey matter’. It has been proposed that increases in grey matter density can be attributed to periods of synaptic growth, and that decreases in grey matter density can be attributed to a combination of myelination (changing grey matter into white matter) or, synaptic pruning (Blakemore, 2012). Studies of grey matter density have suggested the brain appears to go through grey matter ‘growth spurts’. These periods of rapid synaptic growth and corresponding increases in grey matter density occur from birth to four years of age, and from ten to twelve years of age (Wolfe, 2010). Although the brain reaches its final adult size, folding and weight by the physical age of 12, there are a lot of changes that continue within the brain as it matures (Powell, 2006).

In addition to identifying grey matter growth spurts and synaptic pruning, brain scan technology has identified that there is a pattern associated with the process of myelination occurring within the brain. The thinning of grey matter and increase in white matter occurs in a wave ‘like an inverted “U”’ starting at the back of the brain and finishing in the front (Sawyer, Afifi, Bearinger, Blakemore, Dick, Ezeh, and Patton, 2012). Interestingly, the wave of changing grey matter to white matter continues until about 30 years of age (Blakemore, 2012). The finding that white matter development continues in the front of the brain up to the age of 30 is important for this research because it suggests that there is something different about the brains of the WHO-defined ‘youth’ demographic in comparison to adults.
Brain function

This section focuses on the different areas of the brain, and the functions that current neuroscience has associated with them. It is important to note that this area of brain based education has historically come under the most criticism. The emergence of brain based learning in the 1990s proposed some educational theories such as ‘sensitive periods’, ‘left/right brain dominance’ and ‘gender differences’. Educators however, misinterpreted or overvalued limited studies to develop a range of pedagogical approaches. At the time that they were proposed, these theories gained significant popularity and were widely reported in many popular magazines and newspapers. These early brain based educational theories were heavily criticised by psychologists, who argued that the study of behaviour, not biology was the key to education (Bruer, 1999). Unfortunately, much of the debate over brain based education is polarised into the alternate viewpoint of ‘nature’ versus ‘nurture’, neuroscience or psychology (Greenleaf, 1999). The discussion of this topic from these two opposing points of view is unhelpful. As the brain grows, it is not on a course of physical or functional development that is entirely genetically pre-programmed. The brain changes physically in response to environmental experiences and any effective research on the topic must cover both nurture and nature (Jensen, 2008). The ‘nature’ aspect relates to the brain’s functional development, which is the next topic of discussion. The review of the literature into brain function will be limited to those aspects of the brain that are relevant for learning, thought, motivation and behaviour, and will not cover areas of the brain associated with autonomic life support function.

Thalamus, Hypothalamus and Amygdala. Although we are not conscious of the Thalamus, Hypothalamus or Amygdala, it has been suggested that the interplay of these three structures within the brain is very important for understanding how the brain processes information. All
sensory information from the body, less smell, travels to the Thalamus first, with smell travelling directly to the cortex (Wolfe, 2010). The Thalamus sends this information to the Cortex and also to the Amygdala where it is evaluated. The Amygdala assesses the incoming sensory data for potential threats and if a threat is detected, it triggers the Hypothalamus which sends hormonal messages to the body triggering the fight or flight response (Wolfe, 2010). The Amygdala is also widely considered to have a controlling function in the regulation of emotions (Wolfe, 2010), and in adolescents it has demonstrated heightened activation to emotional stimuli in comparison to adults and children (Gilbert, 2012; Spear, 2000). There have been multiple studies that have demonstrated a relationship between positive emotions and increased critical thinking, and cognitive function, and this is likely to be due to the involvement of the Amygdala (Gilbert, 2012). In relation to learning and behaviour it is important to note that this area of the brain is one of the first areas to complete myelination and mature in teenagers (Steinberg, 2014).

Prefrontal Cortex. A sub component of the Frontal Lobes, the Prefrontal Cortex is the area of the brain where complex executive decisions are made. It has been suggested that it is the Prefrontal Cortex that serves to: ‘organise multiple tasks; inhibit specific impulses; maintain self-control; set goals and priorities; empathise with others; initiate appropriate behaviour; make sound judgements; form strategies; plan ahead, and; adapt to changing situations’ (Wolfe, 2010). The Prefrontal Cortex is the last part of the brain to mature and complete myelination (Blakemore, 2011), and some of the common literature on the adolescent brain has purported that adolescents are incapable of rational thought because of this (Casey & Caudle, 2013). Increasing research into the function of the Prefrontal Cortex in adolescents has suggested that there are particular conditions that affect the degree to which adolescents are capable of applying rational thought. In fact, in controlled environments where adolescents
remain unstimulated by emotion, experiments have shown that adolescents can perform equal to or better than adults in relation to supressing a compelling action (Casey & Caudle, 2013). However, the performance of adolescents in comparison to adults diminishes significantly during experiments in self-control when there is emotion involved (Casey & Caudle, 2013). There is also a body of research that suggests the Ventral Striatum (a region of the brain associated with detecting and learning from novel and rewarding environmental cues) can ‘over ride’ the executive control of the Prefrontal Cortex (Casey & Caudle, 2013).

In her paper *Imaging brain development: The adolescent brain*, Sarah-Jayne Blakemore summarises the results of many different studies into adolescent brain development and function. Blakemore refers to many other experiments that have demonstrated the significant difference between the brain function of adolescents and adults. In particular, these studies have focused on the process of ‘mentalising’ or “understanding other people’s actions in terms of the underlying states that drive them” (Blakemore, 2011). Many experiments using different approaches to investigate how adults and adolescents ‘mentalise’ have returned consistent results. Adolescents ‘mentalising’ have greater activity in their Dorso-medial Prefrontal Cortex than adults who had more activity in the Anterior Temporal Cortex (Blakemore, 2011). These results are not conclusive, but suggest that the process of mentalising changes with age. The leading explanation for this change is that adolescents are still utilising their Prefrontal Cortex for complex mentalisation computations but that adults are more reliant on accessing experiences that they have already learnt (Blakemore, 2011). Not mutually exclusive, it has also been suggested that these results reflect the changes to grey matter density that take place through synaptic pruning and myelination (Blakemore, 2011).
**Nucleus Accumbens.** The Nucleus Accumbens is considered to be the area of the brain most significantly involved in processing reward and pleasure, largely due to the release of dopamine that occurs in this region in anticipation of reward or in response to pleasant experience. It is also the area of the brain largely responsible for drug addiction because drugs stimulate the release of Dopamine in the Nucleus Accumbens (Dubuc, Robert, Paquet & Daigen, 2014). Multiple recent studies using a variety of different laboratories, techniques, participants and reward tasks have demonstrated a significant difference in the function of the Nucleus Accumbens in children, adolescents and adults (Galvan, 2013). These studies have suggested that the reward response in adolescents is more intense than in children or adults (Galvan, 2013), and that their Accumbens demonstrates an exaggerated response to large rewards and decreased response to smaller rewards in comparison to children and adults (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006). Some of these studies have also produced results that suggest adolescents are drawn to immediate gains over those that are long term due to the over stimulated Nucleus Accumbens and immature activity in the Prefrontal Cortex (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) (Albert, Chein & Steinberg, 2013).

**Cortex.** The Cortex consists of the Occipital Lobes, responsible for processing visual stimuli; the Temporal Lobes, responsible for auditory stimuli; the Parietal Lobes, responsible for spatial awareness and orientation; the Somatosensory Cortex, responsible for the sense of touch; the Motor Cortex, responsible for muscle movement; and the Frontal Lobes, responsible for complex thought (Wolfe, 2010). When studying white matter density brain scans, the process of myelination or brain maturity follows the order with which these structures were listed, starting with the Occipital Lobes and finishing with the Frontal Lobes (Powell, 2006).
Advocates of brain based educational styles have drawn significant conclusions from the pattern of myelination and how it could potentially explain stereotypical adolescent behaviour. It has been suggested that erratic and impulsive behaviour is a product of over stimulated pleasure seeking Nucleus Accumbens, supported by emotional responses from a mature and developed Amygdala. The Amygdala lacks the moderation and control of a fully myelinated Prefrontal Cortex providing executive function. This does not suggest that adolescents are incapable of performing high level thinking, empathy, or other executive function however, it does imply that they find it more difficult, and they may be more inconsistent, particularly if there is emotion or immediate reward involved.

What neuroscience is beginning to understand about the function, development and relationships between the Nucleus Accumbens, the Amygdala and the Prefrontal Cortex provides a reasonable explanation of stereotypical adolescent behaviour, albeit not proof.

Recently, functional magnetic resonance imaging (fMRI) has been used to identify different brain activity in adolescents who demonstrated unacceptable behaviour and conduct problems such as bullying. These brain scans have suggested that there are two different types of unusual brain activity that can result in common conduct problems. The first of these two categories refers to ‘callous unemotional traits’ where the subjects have ‘reduced sensitivity to visual or vocal displays of distress emotions and poor modulation of behaviour in response to punishment’ (Viding, McCrory, Blakemore, & Frederickson, 2011). They displayed lower amygdala activity in response to others’ distress, abnormal ventromedial prefrontal cortex response to punishment, and ‘disrupted integration of amygdala, orbitofrontal cortex and caudate functioning during reinforcement learning’ (Viding, McCrory, Blakemore, Frederickson, 2011). In essence, the neuroscience was able to explain why adolescents with
callous unemotional traits lacked empathy, demonstrated unacceptable behaviour and had difficulty learning from their mistakes (Viding, McCrory, Blakemore & Frederickson, 2011). Although demonstrating similar behavioural problems, the second category of abnormal function is defined as ‘non-callous’, where the subjects have preserved empathetic ability and the ability to moderate behaviour in response to punishment; however, are oversensitive to anger and punishment cues (Viding, McCrory, Blakemore & Frederickson, 2011). Non-callous subjects have shown increased amygdala activation to both neutral and threatening emotional environments resulting in aggressive responses to even minimal provocation (Viding, McCrory, Blakemore & Frederickson, 2011). Importantly, by understanding the brain function responsible for the behavioural conduct problems, neuroscience is able to provide intervention strategies that are likely to be more effective. Rather than focusing on punishment, or imploring subjects to empathise with their victims, more effective strategies to use with adolescents demonstrating callous unemotional traits or non-callous traits focus on rewards for demonstrating the correct behaviour, or appeal to their sense of self interest (Viding, McCrory, Blakemore & Frederickson, 2011).

There are some psychologists who argue that problems with adolescent behaviour are not a result of the brain, but rather a result of societal influence. In his critical analysis of the ‘Myth of the Teenage Brain’ Robert Epstein cites a study of 186 preindustrial societies in 1991 that identified that 60% of them had no word for ‘adolescence’ and teens spent most of their time with adults and demonstrated very low levels of antisocial behaviour (Epstein 2007). Epstein also refers to studies by psychologists and anthropologists that suggest Western television, increases in laws aimed at curbing behaviour and the ‘artificial extension of childhood’ are all valid reasons to explain stereotypical teenage behaviour (Epstein 2007). In his criticism of neuroscience he states that ‘By their very nature, imaging studies are correlational, showing
simply that activity in the brain is associated with certain behaviours or emotions...correlation does not even imply causation’ (Epstein 2007). Nevertheless, psychology, as a discipline, is exploring the implications of brain development for adolescent behaviour (Albert, Chein & Steinber, 2013; Casey & Caudle, 2013; Galvan, 2013; Jacobs & Klaczynski, 2002; Romeo, 2013; Somerville, 2013; Spear, 2000) and for learning and education (Alexander & Winne, 2006; National Research Council, 2000). Today’s researchers are proceeding cautiously – mindful, perhaps, of some heavily-criticised earlier attempts to develop ‘brain based’ teaching methods which proved to be premature.

This review will now consider those earlier brain based pedagogical approaches and their associated criticisms. As was briefly discussed previously, there has been significant criticism of some earlier pedagogical approaches that were proposed on the basis of emerging knowledge of cognitive neuroscience. In particular, the ‘sensitive period’, ‘left/right brain dominance’ and ‘gender differences’.

The ‘Sensitive Period’

In 1993 a series of articles on brain science by Ron Kotulak ran in the Chicago Tribune (Bruer, 1999). These articles appeared to be the first time that a ‘sensitive period’ for learning between the ages of four and ten was first proposed. The articles referred to Positron Emission Tomography (PET) brain scans research conducted by Dr. Harry Chugani. Dr. Chugani determined that the by the age of four, a child’s brain was using twice the amount of glucose of an adult brain. This consumption rate of glucose remained consistent until the age of ten where it began to decline to adult levels by the age of sixteen or seventeen (Bruer, 1999). Previous post-mortem research into synaptic density had already determined that children had
50% more synapses than adults however, though his research Dr. Chugani proposed that the higher number of synapses were consuming a greater amount of glucose, and that the normalisation towards adult consumption levels was the result of synaptic pruning (Bruer, 1999). Although Dr. Chugani’s findings to this point seem entirely reasonable, it is his additional comment that his findings suggest a learning ‘widow of opportunity’ or ‘sensitive period’ that has come under much criticism for lacking scientific basis. This suggestion of a sensitive period has been misinterpreted by many to state that ‘children’s brains learn fastest and easiest between the ages of four and ten’ (Bruer, 1999). This viewpoint has been accepted by many educators, and capitalised upon by marketers of educational materials advertising everything from ‘pregaphones’ to stimulate brain development in utero, to colourful galleries for the back seat of cars (Jorgenson, 2003). With the benefit of time, these theories about ‘sensitive periods’ for learning have been tested, and the only valid evidence supports a ‘critical period’ for learning a first language, all of the other developmental requirements are met through normal social behaviour (Kluger, 2001).

**Left/Right Brain Dominance**

It has been suggested that the different hemispheres of the brain control different academic functions, that the left hemisphere is ‘logical’ and concerned with speech, reading, writing and analysis and that the right hemisphere is ‘intuitive’ and responsible for spatial patterns and creativity (Alferink and Farmer-Dougan, 2010) (Bruer, 1999). Some educators such as David Sousa have proposed that different teaching strategies can be employed to more effectively educate left or right hemisphere dominant students (Sousa, 1995). For example, Sousa suggests teachers encourage their students to generate and use mental images in order to ‘involve the right hemisphere’ (Sousa, 1995). The roots of this belief have been based on studies into patients who have had the connective tissue that enables communication
between the left and right hemispheres severed. The severing of this tissue, the corpus callosum, was performed to reduce or eliminate debilitating seizures in these patients, and provided a unique opportunity to study the impacts this surgery on normative function (Alferink and Farmer-Dougan, 2010). One of the specific studies related to the use of mental imagery was conducted by showing a lower case letter to the patients and asking them whether the corresponding capital letter had any curved lines (Bruer, 1999). This task required the patients to mentally create an image of the capital letter before making a judgment on whether or not there were curved lines. When the image was presented to the left hemisphere the patients performed perfectly on the task; however, when presented to the right hemisphere their performance was greatly diminished (Bruer, 1999). Although results such as these were the basis for the learning strategies proposed by Sousa and other proponents of left/right hemisphere teaching, brain scans of people with the corpus callosum still intact completing similar mental imaging tasks, provide evidence that both hemispheres of the brain were involved in the task (Posner and Raichle, 1994). Although it might be argued that Sousa’s strategy of ‘visualising’ an image may assist the creation of memory, there is no evidence to suggest that it is because the action has specifically or intentionally engaged the right hemisphere (Bruer, 1999). The overwhelming evidence from multiple studies suggesting that there is no validity to teaching styles that target left or right brain hemispheres.

**Gender differences and learning**

An extension of the left versus right brain hemisphere approach is that females tend to be left hemisphere dominant, and are better with verbal communication, are analytical and better at solving problems (Bruer, 1999). Conversely, it has been suggested that women are less comfortable with algebra, geometry and spatial problems where the supposed problem solving defunct males are meant to shine (Bruer, 1999). Although psychologists have
conducted studies that show males perform better than females at mentally rotating objects, this appears to be the only established area of difference between the mental ability of males and females (Bruer, 1999). Although neuroscientists and psychologists disagree on many aspects of brain based education, in reviewing the available literature, the one area that both sides of the debate seem to agree on is that there is no evidence of significant difference between the mental ability of males and females. There is however, evidence of differing brain development between males and females.

The density of grey matter development in the frontal lobes reaches its peak in girls at 11 years of age, and at 12 years of age in boys (Blakemore, 2011). There is also evidence that suggests growth in the amygdala volume occurs only in boys during puberty, and increases in hippocampus volume occurs only in females (Blakemore, 2011). The understanding of the different brain development of adolescent males and females and the impacts of testosterone and oestrogen in this process are only now being investigated; however, there are suggestions that brain development is more closely aligned with physical sexual maturity than actual age in years (Blakemore, 2011). There is also evidence to suggest higher levels of risk taking behaviour in males than females (Vermeersch, T'Sjoen, Kaufman, and Van Houtte, 2011). However, the reasons for these differences have been attributed to many factors that seem to be more related to experience than biology (Byrnes, Miller, Schafer, 1999). Interestingly, the gap between different approaches to risk taking behaviour between males and females narrows as the age increases (Byrnes, Miller, Schafer, 1999).
Other criticisms of brain-based learning

In addition to these justifiable criticisms of unqualified brain based teaching strategies, there have been other overstated inferences drawn from neuro-scientific studies that have devalued the argument for brain based learning. Much of the mass media hype in the late 1990’s about neuroscience finding the reasons for stereotypical adolescent behaviour was based on a study conducted in Chicago by Deborah Yurgelun-Todd and colleagues. These studies used brain scan technology to compare the function of adult and adolescent brains whilst viewing photographs of adult faces depicting certain emotions (Payne, 2012). Also known as the ‘Chicago Studies’, Deborah Yurgelun-Todd and her colleagues concluded that their experiments showed that adolescents were ‘much less competent than adults at recognising the emotional state of others’, and indicated a much heavier reliance on the Amygdala by adolescents, in comparison to adults who used their Pre-Frontal Cortex in evaluating the depicted faces (Payne, 2012). Although critics of the Chicago studies don’t dispute the findings of the experiments, they have been heavily critical of the weight that has been given to the results in the mass media and the additional inferences that have been drawn. Central to the criticism is the limited nature of the experiments which were conducted on ‘12 healthy participants aged 12-17’ (Payne, 2012). Monica Payne has even suggested that the reliance on this limited study and the degree to which it has been referenced reflects the evolution of ‘folk tales’ and in some instances the source data is no longer referred to; the conclusions are merely presented as factual (Payne, 2012).

Since the Chicago experiments there have been many additional brain scan studies that have investigated the differences of brain function among children, adolescents and adults, of both sexes, and in different cultures (Blakemore, 2011). Although some of the early research in this area and the inferences made have been subjected to reasonable criticism, the same could be
said of most emerging fields of study. The continued focus of critics on what neuroscience ‘can’t prove’ instead of cautious consideration of what neuroscience ‘can suggest’ could be considered quite dogmatic. Often, critics such as Bruer continue to refer to the earlier disproved brain based learning strategies in order to make a convincing argument however, in making their arguments, they seem to consciously omit modern research and the refined argument for brain based approaches. In more recent times the advocates of brain based education have defined their field as ‘the engagement of strategies based on principles derived from an understanding of the brain’ and they importantly note that this definition does not include or exclude neuroscience or psychology (Jensen, 2008).

**Brain ‘health’**

There is significant research that indicates the importance of health, exercise and nutrition in relation to effective brain growth, and cognitive function. There is a high correlation between exercise and neurogenesis (the production of new brain cells), and neurogenesis is linked to improved memory and learning (Jensen, 2008). There also appears to be a link between a lack of exercise and depression. Exercise regulates the release of serotonin, dopamine and norepinephrine that are all associated with mental health (Medina, 2012). Exercise and a healthy diet also improves the efficiency of oxygenated blood reaching the brain, and can increase the size of the dentate gyrus, a part of the hippocampus that is important with the formation of memories (Medina, 2012). The impact of exercise on brain growth, cognitive function and mental health is so significant that it should be a consideration of any effective learning strategy. In addition to exercise, sleep is a vital aspect of effective brain function and cognitive ability, it is also another area of brain research that identifies different requirements for adolescents in comparison to children and adults. In this regard, it has been suggested that the amount of sleep required is linked to the process of physical growth and sexual maturation.
because the hormones critical for these processes are released during sleep periods (Wolfe, 2010). Sleep is also important for the process of learning and formation of memories, specifically the movement of memories from short to long term (Wolfe, 2010). Research has shown that in order to function optimally during the day adolescents require nine hours and fifteen minutes sleep per night in comparison to adults who only require eight hours (Wolfe, 2010). Interestingly, this same research has also demonstrated that adolescents have a different circadian rhythm than adults and their brain are not actually ready to wake up until 8-9 o’clock in the morning (Wolfe, 2010). Effective learning strategies should consider the importance of sleep and exercise when dealing with adolescents.

The period of ‘youth’ from 15 to 24 years of age represents a significant period of social, physical and cognitive change for those in average western based societies. Teenagers and young adults have the opportunity to selectively seek the company of their own age group rather than interacting with more mature adults, and their behaviour is often stereotyped as risky, self-indulgent and emotive. Regardless of whether stereotypical adolescent behaviour is the result of nature (how the brain grows and functions) or nurture (environmental influence and experience), cognitive neuro-science is increasing our knowledge of brain development and function in adolescents. Although adolescents have a functioning prefrontal cortex capable of rational thought, the immature myelination of the neurons limits their capacity for normative executive function in response to threats, emotional stimuli and novel cues. In such circumstances it appears the Amygdala or Ventral Striatum can over-ride executive function and result in emotive or heightened risk taking behaviour at the expense of reasoned thought. Cognitive neuro-science has also identified some characteristics of youth brain development that provide opportunities for leveraging cognitive function towards learning. The adolescent brain has an exaggerated response to novelty, rewards, and research has suggested that
adolescents respond more effectively to those rewards that are immediate. Although the emerging neuro-science on adolescent brain development and function is interesting in isolation, when considered in conjunction with educational psychology it becomes compelling.

How people learn

This thesis will now apply the putative findings on adolescent brain development to the topic of learning, as conceptualised by Educational Psychology. In doing so, it will attempt to identify potential differences between learning strategies that are effective for adults or children and learning strategies that may be more effective for adolescents. The prevailing theoretical view of learning, in Educational Psychology, is constructivism (Alexander & Winne, 2006; National Research Council, 2000). Constructivism posits that knowledge cannot simply be transmitted directly from a teacher to a learner – two mottos of constructivism are telling ain’t teaching and learning is not a spectator sport. Instead, learners must construct their own mental knowledge structures, as they engage in learning activities designed by a teacher for this purpose. Traditional, didactic teaching ‘by transmission’ typically results in simplistic, disconnected ‘factual’ knowledge structures which may allow a student to answer simple factual questions but, in most cases, do little more than that. Effective problem solving, transfer of learning and professional competence require deeper conceptual understanding. Deep conceptual understanding requires learners to spend considerable time and effort thinking about concepts, exploring the relationships among concepts, reconciling new and pre-existing concepts and applying concepts to the external world. Such learning requires sustained mental effort.
Student motivation is crucial for generating the engagement and mental effort required to achieve deep conceptual understanding. Other factors that are particularly important for constructivist learning are: social environment, prior knowledge, organisation of knowledge and development of mastery through application (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010; National Research Council, 2000; Knowles, Holton III, & Swanson, 1998). In the process of reviewing the concept of learning as explained by educational psychology, this paper will also return to some of the previous discussions regarding brain growth and function to demonstrate that the best educational strategies draw from all fields of study.

**Motivation.** In the field of educational psychology, the concept of motivation or engagement is considered to be highly important. Motivation has been described as the ‘personal investment that an individual has in reaching a desired state or outcome’ (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In relation to learning, a student’s motivation will determine the direction, intensity, persistence and quality of their engagement in learning behaviours (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). A student’s motivation, or personal investment in reaching a particular outcome is generally determined by a combination of the value that they align with the goal, and their personal expectation of achieving the goal (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In this regard the concept of ‘value’ can be *attainment value* (satisfaction from accomplishment), *intrinsic value* (satisfaction from doing the task), or *instrumental value* (satisfaction from extrinsic rewards such as praise, public recognition, money or status) (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In relation to ‘expectation’, students are unlikely to be motivated towards goals that they perceive to be unattainable, and more likely to be motivated towards goals where they expect to be successful (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).
One relevant question suggested by studies of adolescent brain development is whether adolescent learners are motivated in the same ways, and to the same degrees, as children and adults. As previously discussed in this review, studies have demonstrated that adolescent brains show an exaggerated response to rewards in comparison to children and adults, and that adolescents seem drawn to short term rewards rather than long term goals. This may imply that adolescent learners could be more sensitive than either adults or children to extrinsic rewards. Accordingly, in developing adolescent learning strategies, it may be particularly important to focus on determining the types of extrinsic rewards that are valued by adolescents, and perhaps develop teaching strategies that emphasise immediate reward as an effective motivation tool. This suggestion runs counter to prevailing recommendations from educational psychologists, who emphasise intrinsic motivation by harnessing students’ interests rather than extrinsic motivation by emphasising rewards. The possibility that adolescents may require some modification of this advice is suggested by the neuro-scientific studies and should be investigated further.

Goal Theory is another school of thought that researchers have used to try and understand the motivation of learners in formal education contexts. Although using different language such as Achievement Goals, Social Goals and Future Goals there are similarities with the concept of attainment value, intrinsic value and instrumental value that have previously been discussed. In Goal Theory, Achievement Goals are further segregated into Performance Goals, that involve “a desire to gain favourable judgement and avoid negative judgements of one’s competence” and, Mastery Goals that reflect “developing competence and increasing knowledge and understanding through effortful learning” (Mansfield, 2010). Students motivated by Performance Goals tend to demonstrate high achievement focused on external rewards however, their learning can be shallow and their retention of knowledge can be
limited (Mansfield, 2010). By comparison, students motivated by Mastery Goals tend to be interested in problem solving, have personal achievement standards and high cognitive engagement (Mansfield, 2010). Social Goals are further categorised as Social Responsibility Goals (compliance with rules and expectations), Prosocial Goals (the desire to help, share and cooperate), Relationship Goals (the desire to be liked and establish relationships) and, Status Goals (to be well regarded in the peer group) (Mansfield, 2010). Future Goals are considered to be the motivation for future desires such as ‘career, employment, materialistic possessions, success and happiness’ (Mansfield, 2010).

Since deep conceptual understanding requires a considerable investment of time and effort by the learner, mastery goals are typically considered to be more beneficial for learning. However, it is important to recognise that at any one time there are multiple goals that influence a learner’s motivation. The goal-orientation that learners actually adopt can be influenced by the goal structure of the learning environment (i.e. what is rewarded). Learning environments that reward mastery can influence learners to adopt mastery goals. However, goal structures in the learning environment can be complex. In some environments, important goals will be competing with each other in a mutually exclusive fashion. For example, a learner is likely to have difficulty focusing on Future Goals of instrumental value if their expectations are being limited by failures to achieve Social Goals. Mastery goals are always beneficial for deep learning, but for learners to adopt mastery goals, the learning environment should align a mastery goal structure with other goals that are valued by those learners.

In designing adolescent learning environments, it is particularly important to know which goals are valued most highly by adolescents and to align those goals with mastery in the goal structure of the environment. If a learning environment misaligns mastery goals with other
goals that are particularly important to adolescents, such as status goals or relationship goals, then adolescent learners will be placed in a position where they must choose between mastery and social status (or relationships).

Another issue that may be particularly relevant for adolescent learners is the effective time-horizon of future goals. Although there is significant research that demonstrates the links between future goals and immediate motivation (Mansfield, 2010), there does not appear to be research that considers motivational levels for future goals in relation to how far away the goal is in time. Many of the studies in relation to future goals for adolescents have been focused on high school students in their senior year, and their future goals have generally been relatively short term; to do well enough at school to achieve their desired career or entry requirements for further tertiary education. When considering the neuroscience that has suggested the Nucleus Accumbens in adolescent brains respond more actively to immediate rewards than those that are long term, it would be an interesting area for future research to consider the influence of future goals as a motivator for adolescents over differing time horizons.

Social Environment. Studies have also suggested that a student’s motivation and expectation for success are directly linked to their perceptions of whether the environment is supportive or unsupportive (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In this regard, supportive environments have been suggested to have approachable instructors and helpful colleagues, in comparison to unsupportive environments where the instructor may demonstrate hostility or unconscious bias. The impact on student attitudes to learning resulting from studies into the interrelations of motivation, expectation and supportive or unsupportive environments are
presented in the following table (recreated from: Ambrose, Bridges, Lovett, DiPietro & Norman, 2010):

<table>
<thead>
<tr>
<th>Student’s sense of value is:</th>
<th>Unsupportive Environment</th>
<th>Supportive Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Don’t see Value</td>
<td>See Value</td>
</tr>
<tr>
<td>Student expectation of achievement is:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Rejecting</td>
<td>Hopeless</td>
</tr>
<tr>
<td>High</td>
<td>Evading</td>
<td>Defiant</td>
</tr>
</tbody>
</table>

Table 1: Interactive effects of Environment, Expectation, and Value on Motivation (recreated from: Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).

In explanation of Table 1; when students in both supportive and unsupportive environments don’t see value in a task and have low expectations of being able to achieve it, they become ‘rejecting’; disengaged from learning, apathetic about results, and in some cases can become angry about the situation (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). When students in both supportive and unsupportive environments don’t see value in a task however, have a high expectation of being able to achieve it they can become ‘evading’; the task is considered doable but unimportant and they are easily distracted, prone to procrastination and may be satisfied with completing the task to the minimum required standard (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).

Those students who see value in a task but, have limited faith in their ability to meet the requirement, can have two different responses depending upon the environment. Those in supportive environments can have a ‘fragile’ response; they feel supported and want to succeed, but their lack of faith in their own abilities can result in them feigning understanding, avoiding participation if possible, or offering excuses for substandard performance (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). However, those in unsupportive environments can
feel ‘hopeless’; and have very low levels of motivation because they don’t believe they can achieve the requirement and feel there is no one they can turn to for help (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).

Students who see value in the task and have a strong belief in their ability to achieve it can also have two differing responses depending upon the environment. Those students in supportive environments are ‘motivated’; they are highly engaged in their own learning and want to enhance their understanding (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In difference, those students who are in unsupportive environments can become ‘defiant’; setting out to achieve in spite of the unsupportive environment (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). The provision of a supportive environment is a very important consideration for learners of all ages.

In addition to the importance of supportive environments for learning, there are other social factors that have a significant influence of adolescent learning. There have been multiple studies conducted into the concept of peer group influence on adolescent behaviour. Research conducted using a car driving game found that adolescents took many more risks when in the presence of peers than when performing the task by themselves (Burnett & Blakemore, 2009). This research has been reinforced by statistical data from the Association of British Insurers that found compared to driving with themselves, teenagers are three times more likely to have a fatal crash when traveling with peers (Burnett & Blakemore, 2009). Although this review has already provided significant neuro-scientific research that supports the heightened risk taking behaviour of adolescents, this additional research demonstrates that the presence of peers in their social environment, elevates the likelihood of risk taking behaviour (Albert, Chein & Steinberg, 2013). During the car driving game described above, adolescents had significantly
more activation of their Ventral Striatum when performing the activity in the presence of their peers, and these experiments have provided the first neuro-scientific explanation for the influence of peers on adolescent risk taking behaviour (Albert, Chein & Steinberg, 2013). In considering the previous discussions regarding values and goals, this may constitute a neuro-scientific explanation for the increased value in relationship and status goals in adolescents, and suggest that learning strategies should take this into consideration when developing motivational tools. These experiments may also help explain why ‘learning something’ may not always equate to a change in behaviour. Many driving programs teach adolescents about the dangers of reckless driving, but the incidence of vehicle accidents when adolescents are driving with their peers suggests that it does not change their behaviour (Steinberg, 2007). In light of neuro-scientific research it may be that ‘education’ by itself is an ineffective strategy for changing reckless driving or other risky behaviours in adolescents. Perhaps other approaches such as banning adolescent passengers may be a more effective strategy for moderating behaviour.

The importance of the peer group as an adolescent social environment has been the subject of several studies that have demonstrated adolescents’ sense of wellbeing is most significantly affected, positively or negatively, by interactions with their peer group rather than those interactions with adults or children (Gilbert, 2012; Somerville, 2013). The impacts of the social environment and influence of the peer group cannot be underestimated when developing adolescent learning strategies. Studies have shown that adolescents under social scrutiny by their peers respond with a significantly higher release of the stress hormone cortisol than similar experiments with children (Somerville, 2013). Adopting learning approaches that avoid the risk of adolescent’s losing status with their peers are the best ways to maintain motivation and avoid adolescents feeling threatened and disengaging from learning.
Prior Knowledge. The presence of inaccurate prior knowledge is a significant obstacle to the process of learning and can result in students ignoring, discounting or resisting information that contradicts what they believe to be true (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In some cases, before learning can occur, obstacles such as inaccurate prior knowledge, must be challenged and corrected. Some inaccuracies within a student’s prior knowledge are easy to correct if they are isolated beliefs that are not linked to a larger conceptual model (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). However, misconceptions that are based on models or theories are much harder to correct (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). Misconceptions are often based on stereotypes, they can contain mixtures of accurate and inaccurate information and are reinforced over time through multiple contexts (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). Research has demonstrated that deeply held misconceptions often persist despite direct instruction to try and rectify the inaccurate knowledge (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). In developing learning strategies to rectify inaccurate prior knowledge, it is important to understand that it can take time, and that the new learning might not override the misconception immediately (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). When distractions and time pressures are removed, research suggests students are more capable of applying the additional cognitive effort and rational thought required for the new learning rather than relying on intuition (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). It is also possible to use techniques such as ‘bridging’ to help rewrite the misconception. Rather than trying to correct the entire theory, by deconstructing the overall concept into its individual information component parts; correcting each one individually, and using that as the basis for correcting the next idea, the misconception can be ‘bridged’ (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).
Organisation of knowledge and development of mastery through application. There has been considerable research conducted into the different manner with which knowledge is organised through the process of learning. Much of the language around this discussion focusses on the differences between novices and masters (or beginners and experts) within a given field. At the novice level, learning tends to be superficial and focused on memorising facts often in isolation to the larger ideas to which they contribute (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). Assessments of novices can tend to give a better understanding of a student’s memory than what they have learnt. By comparison, masters organise their factual knowledge into meaningful patterns that reflect contexts of applicability enabling adaptive application (National Research Council, 2000). In simple terms, the difference between a novice and a master is that a novice may be able to recall a specific memorised fact however, a master may be able to determine the same answer based on a broader understanding of the context of the problem, even if the actual fact wasn’t committed to memory. Although developing true mastery takes time, it is possible to help student develop their learning like a master through the application of effective learning strategies. To develop mastery, students need to learn the basic facts, practice integrating them fluently and then understand when and where to apply them (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). To learn the basic facts, it is important to be able to break complex problems down into all of their individual component parts and help students learn the things that they are finding difficult rather than seeking the pleasure of the things they find easy (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). The process of integrating basic individual component parts into a larger more complex problem can be quite difficult because of all the variables that might be involved. Each variable requires a level of cognitive ability, and the more of these variables that are introduced at once the more difficult the process of integration becomes. If the cognitive load becomes too much the learning will stop. Accordingly, it is important to build the ability to integrate facts in larger complex problem in manageable chunks that can be practiced until they can be achieved with
little cognitive effort. Once an integrated task can be achieved with little cognitive effort, it can be further integrated and the process continues until the entire complex problem has been learnt. This learning process will help the students develop experience, pattern recognition and the ability to short cut the processes when appropriate in exactly the same way that masters operate (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).

In considering literature on educational psychology it is evident that there are no contradictions or concepts that are mutually exclusive from the emerging field of cognitive neuro-science. In fact there is significant examples of where the two fields of study directly support the respective theories through different research and evidence.

**Summary of Chapter 2**

This research into brain growth and maturation clearly showed that although grown to adult size, adolescents’ brains function differently than the brains of children or adults. In general this difference is evident until 25 years of age however, in some instances can continue in varying degrees up to 30 years of age. In and of itself, this evidence suggested a detailed examination was required of the brain function and behaviour of the adolescent age demographic in order to identify the best strategies to facilitate their learning. Reviewing educational psychology suggested that motivation and supportive social environments were vital for effective learning. However, examining the neuroscience literature identified that adolescents have difficulty with impulse control, empathy and higher decision making (such as understanding second and third order effects). This is because their Prefrontal Cortex (responsible for these functions) had not finished myelination (a process that speeds the communication between neurons). In contrast, the Amygdala is fully myelinated in
adolescents. The Amygdala is responsible for emotion, threat detection and activating the body’s ‘fight or flight’ response; because it is fully myelinated, it can send messages much faster than the Prefrontal Cortex and ‘hijack’ the decision making of an adolescent. It was also identified that adolescents had an exaggerated response to reward stimuli and that they favoured immediate gratification rather than long term rewards. It was also suggested that ‘status with their peers’ was one of the most highly valued rewards amongst adolescents. Independent research from both behavioural psychology and neuroscience also identified that the risk taking behaviour of adolescents increased in the presence of their peers. This phenomenon appeared to be much more significant than ‘peer pressure’ and seems to be linked to the activation of a part of the brain’s reward mechanism, the Ventral Striatum. The Ventral Striatum activates in adolescents who are in the company of their peers and rewards them with Dopamine for participating in novel activities.

Malcolm Knowles’s (1980) model of andragogy is based on 6 principles of adult learning (outlined in chapter 4). In partial contrast, the review of the research literature in this chapter suggests that the following 9 principles should guide the design of learning environments intended to engage adolescents:

1 – ‘Motivation’ is the key to learning and it is only achieved when students value what is being taught, have a high expectation of success, and are provided with a supportive environment (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010) (Gilbert, 2012).

2 – Adolescents favour short term extrinsic rewards, and in comparison to children and adults they have an exaggerated pleasure response to things they find rewarding (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) (Albert, Chein & Steinberg, 2013).
3 – Adolescents place significant value on status with their peers (Gilbert, 2012) (Somerville, 2013). Losing peer status is a significant threat that can paralyse learning, gaining peer status is significantly rewarding.

4 – Prior learning based on stereotypes and incorrect facts is a barrier to new and correct learning. Incorrect prior learning can be persistent, even in response to positive corrective action (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010).

5 – Adolescents have difficulty considering second and third order effects, they lack impulse control, an understanding of risk, and are drawn towards novel activities; particularly in the presence of their peers (Blakemore, 2012) (Casey & Caudle, 2013) (Viding, McCrory, Blakemore, & Frederickson, 2011). Accordingly, the application of consequences or punishment for bad behaviour is likely to be less effective than the preventative mechanisms associated with supervision, guidance and mentorship.

6 – Supportive and controlled emotional environments promote adolescent learning, and any emotion can hijack rational thought (Gilbert, 2012) (Spear, 2000).

7 – Adolescents have a reduced capacity for empathy (Blakemore, 2012) (Viding, McCrory, Blakemore, & Frederickson, 2011) and accordingly have difficulty viewing a situation from any perspective other than their own. Learning should shaped from their own perspective, not how it ‘feels’ to be someone else.

8 – Physical fitness improves cognitive ability and mental health (Jensen, 2008) (Medina, 2012).

9 – Adolescent behaviour is not necessarily predictive of future adult performance. Much like physical maturity, myelination of the brain is a biological process that can’t be accelerated through education. However, establishing the right foundations and neural pathways during adolescence may shape future adult behaviour.
In chapter 4, a set of ADFA-specific adolescent learning strategies will be developed, based on these 9 principles drawn from the research literature. However, before doing so, chapter 3 will outline the recent history of reports into ADFA and its learning environment, to place this study in context.
Chapter 3 – Establishing the Context for Change

Throughout the relatively short operation of the ADFA there have been several behavioural incidents that have resulted in formal reviews into not only the ADFA, but in some instances the whole ADF. These reviews into aspects of behaviour, culture, organisation, discipline, alcohol use, social media, and treatment of women, amongst others, have all made recommendations for improvements within ADFA, the ADF as a whole, or audited the progress in relation to previous recommendations. The implementation of the recommendations from these previous reviews changed ADFA in an effort to improve behaviour and provide a safer and more inclusive working environment. Each of these reviews was conducted by highly qualified and experienced lead reviewers, working in many cases with expert teams of staff. Accordingly, it would be presumptuous, in any way to ‘analyse’ these previous reviews; however, it is important for context to provide an explanation for why ADFA changed its approach, in some aspects contrary to the recommendations of previous reviews, and adopted an Adolescent Learning Strategy in 2011.

The previous chapter provided a detailed review of adolescent brain development, function and educational psychology. With a basic understanding of the most recent research into adolescent brain function, development and educational psychology, it is possible to reconsider some of the recommendations of the previous reviews into ADFA to determine whether they remain consistent with current best practice. The aim of this chapter is to conduct a brief holistic consideration of the recommendations of previous formal reviews into ADFA to highlight opportunities for further improvement based on the most recent research into adolescent brain development and therefore justify the change in learning strategy commenced by ADFA in 2011.
The holistic consideration of reviews into ADFA will focus on the following reviews:

- 1998 *Report of the review into policies and practices to deal with sexual harassment and sexual offences* by Bronwyn Grey, Director Defence Equity Organisation. Hereafter referred to as: The Grey Review.


Although the above list is not complete, it reflects those reviews that are published on the Defence website and freely available, and those that are considered to be most significant and applicable. It is acknowledged that there are additional reviews that are not published on the Defence website and accordingly, they would need to be requested through Freedom of Information legislation.

**Holistic Consideration**

Between them, the Grey, Kafer and Broderick Review Phase 1 contain 171 individual recommendations organised in 35 themes or chapters. For the purpose of conducting a holistic analysis, the outcomes of these reviews have been summarised into the following common themes applicable to the learning environment: Culture and Unacceptable Behaviour, Cadet Training and Development.
Culture and Unacceptable Behaviour. The Grey Review defines culture as ‘a set of beliefs and practices that are found at the Defence Academy which allow it to function and reproduce itself’ (Grey, 1998). Each of the reviews into ADFA have expressed varying concerns with regards to the culture of ADFA. Throughout each of the reviews these concerns are expressed in relation to unacceptable sexual behaviour, intolerance of physical weakness, aggression, negative social behaviours, limited acceptance of females, lying and binge drinking. Although analysis of these reviews over time demonstrates a downward trend in the volume of negative cultural activity, the behavioural problems still remain to some degree. Why is this the case?

As previously stated, ADFA has implemented most of the 171 recommendation from the Grey, Kafer and Broderick Review’s. Perhaps it is possible that the residual problem behaviour at ADFA is no longer ‘cultural’? An expansion of the opening definition for ‘culture’ would suggest that the ‘beliefs and practices’ must be accepted, so that they can be passed on to the next generation and be ‘reproduced’. This would further suggest that the culture would either need to be endorsed by the staff (through either action or complicity), or be a sub-culture known only to the officer cadets. If we can accept the conduct of these reviews and the implementation of their recommendations as evidence that staff are not complicit in any unacceptable culture at ADFA, then the continuance of behavioural problems must either be a product of a cadet sub-culture or something else. Without seeking to diminish the significant cultural problems at ADFA during the time of the Grey Review, many of the concerns attributed to culture in recent times are not unique to ADFA or the military environment. Unacceptable sexual behaviour, intolerance of physical difference, aggression, negative social behaviours, limited acceptance of females and binge drinking are all apparent in broader society. Does the recent research into adolescent brain development and educational psychology provide an alternate explanation for continuance of problem behaviour at ADFA that is different to the presence of a self-replicating sub-culture?
From the literature review in the previous chapter it has been shown that adolescent brains perform very differently to those of adults; they have difficulty with impulse control, empathy and higher decision making (such as understanding second and third order effects); they have an exaggerated response to reward stimuli, and favour immediate gratification rather than long term rewards; and, their risk taking behaviour increases in the presence of their peers. It is also likely that upon arriving at ADFA, their perception of military culture has been heavily influenced by a lifetime of Hollywood stereotypes, and that this incorrect prior learning could be a barrier to the contemporary message about inclusiveness and respect being taught by the current AMET program. In considering current behavioural problems at ADFA, it may be more likely that continued behavioural issues are the result of the flawed decision making process of adolescents with immature brain’s and a preconceived idea of ‘military culture’, rather than the continuance of a self-replicating cultural problem within ADFA itself.

With regards to the identified behavioural problem associated with the high incidence of Midshipmen and Officer Cadets lying, there may also be an explanation that draws on recent research into adolescent brain development. Not unsurprisingly, most of the lying occurred in relation to midshipmen and officer cadets attempting to avoid taking responsibility or being punished for things that they may have done wrong. The military values integrity as one of the most important characteristics of its leaders, after all, how can leaders be trusted with the lives of subordinates, if they can’t be trusted with the truth. Accordingly, lying to avoid potential punishment is regarded as a significant failing within an officer training establishment; demonstrating not only a lack of integrity, but also a lack of courage. However, understanding the brain function of an adolescent helps explain the prevalence of this behaviour in an establishment like the Defence Academy. Sight, sound, touch and taste travel to the Thalamus within the brain first and then to the Cortex and Amygdala at the same time.
The Amygdala conducts a threat assessment and, if required, engages the body’s fight or flight response. In the adolescent brain the Amygdala is fully myelinated however, the Prefrontal Cortex (responsible for judgement and higher thought) is not. Therefore, the Amygdala can send much faster messages than the Prefrontal Cortex, in essence hijacking rational decision making in response to a detected threat. Although the fear might be perceived and not ‘real’, from an adolescent perspective there is much to be fearful about at ADFA. It is generally the trainees’ first time away from home and their parents; they are in an unfamiliar military environment; they are surrounded by experienced military staff; they have to contend with a Defence Force Discipline Act that results in significant punishments and a permanent record of any indiscretion; and the consistently demonstrated likelihood of an incident leading to negative media reporting, and the termination of their career before it has even started. Within this environment, it is highly likely that adolescents do a great deal of their decision making with their Amygdala, and it is probably this reason that explains why the incidence of lying is so high. The best way to deal with lying may be to address and minimise the things that may be creating the fight or flight response, and try to move the weight of the decision making from the Amygdala to the Prefrontal Cortex.

**Officer Cadet Training and Development.** Each of the formal reviews into ADFA have placed considerable focus on the learning strategy and environment at ADFA. This has been a particularly difficult task given that some of the Midshipmen and Officer Cadets are technically still minors, whilst others are legally adults, and all are training to be officers in the ADF with the highest expectations of responsibility and accountability. In recognition of the significance of their future responsibility as officers in the ADF, most reviews have recommended treating the midshipmen and officer cadets as adults, whilst recognising they are still young people, lacking experience and in need of considerable supervision. The desire by these reviews to
treat the cadets as adults in relation to responsibility and accountability was also applied in the educational strategy with the application of an adult learning environment. Interestingly however, the later reviews refer to a significant lack of student motivation. Based on the relatively recent research considered in Chapter 2, this lack of motivation provides a clue that there may be an alternate approach to adult learning required.

From the previous literature review’s analysis of educational psychology we understand that learner motivation is linked to three important factors; the supportive nature of the environment, the student’s expectation of success, and the value the students attribute with the lesson (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). From research into adolescent brain function we also know that adolescents are reward driven, respond best to immediate rewards (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) and that adolescents value status with their peers above most other rewards (Somerville, 2013). Accordingly, it is possible that the best strategies for addressing the motivation of Midshipmen and Officer Cadet’s would involve: providing a supportive and encouraging environment, with a high expectation of success, and a focus on immediate rewards (in particular, rewards that elevate peer status). Additionally, and possibly most difficult to achieve, the applied strategies would consider the importance of giving all learning a sense of value amongst the adolescent audience.

As chapter 4 will discuss, what adolescent learners tend to value is very different from adult learners, and accordingly there is sufficient research and evidence to suggest that an adult learning environment may not be the best way to motivate adolescent learners and therefore justify the consideration of a bespoke adolescent learning model to improve the learning experience.
Summary of Chapter 3

The aim of this chapter was to establish the context for changing ADFA’s learning strategy from an adult learning environment to a pedagogy more specifically tailored to adolescents. By conducting a brief holistic consideration of the recommendations of previous formal reviews into ADFA, the chapter has identified areas where recent research into adolescent brain development and educational psychology may improve the learning experience of trainees at ADFA. In doing so, this chapter has provided justification for further consideration of a bespoke adolescent learning strategy in difference to the adult learning environment previously recommended by multiple formal reviews.
Chapter 4 - Designing an adolescent learning strategy

The detailed analyses conducted by this research into the Grey, Kafer, and Broderick reviews has suggested that some of the recommendations made by these reviews are inconsistent with contemporary research on adolescent brain function and educational psychology. In particular the repeated recommendation that ADFA be operated as an adult learning environment has been questioned. This chapter will explain why a specifically-tailored adolescent learning strategy might be more suitable than Knowles’s (1980) andragogy for educating 17 to 23 year old officer trainees at ADFA.

1 – That adults needed to know the reason for their learning;

2- That adults could draw upon experience to aid their learning;

3 – That adults need to be involved in planning their education and evaluation;

4 – That adult readiness for education was linked to changes in their social roles;

5 – That adults want to apply new learning in problem solving immediately; and

6 – That adults provide their own motivation for learning from internal factors.

These six characteristics are based on the premise that ‘adults’ are people who have the authority, the judgement and the pre-existing knowledge and experience to make their own good decisions about what they need to learn (curriculum planning), why they need to learn it (intrinsic motivation), how they should go about learning (instruction) and whether they have mastered it sufficiently (evaluation). A relatively cursory analysis of these six factors identifies some inconsistencies between andragogy and the characteristics of adolescent brain function and behaviour identified during the review of literature. Perhaps the most significant issue is
that adolescents have limited intrinsic motivation, and accordingly are potentially less likely to provide their own readiness or motivation for learning. The trainees at ADFA have limited experience that they can use to aid their learning. Many are living away from their parents for the first time, they are generally completely new to the military, they are earning their first full time wage, and they are surrounded with a new social environment consisting exclusively of selected candidates with demonstrated high performance. Their prior participation in primary and high school education techniques generally means that they lack the knowledge or experience to participate in the planning and development of their own tertiary level education and evaluation. Finally, much of their new learning can’t be applied until after they graduate, are promoted as officers, and complete their initial single service specialisation training (anywhere between three to six years after they first commence training depending upon their service and specialisation). Due to the incompatibility of the adolescent mind with characteristics of andragogy, a different approach may be more effective. In the summary of the Chapter 2, it was suggested that following principles from the research literature may form the foundation of an adolescent learning strategy:

**Proposed Adolescent Learning Factors**

1 – ‘Motivation’ is the key to learning and it is only achieved when students value what is being taught, have a high expectation of success, and are provided with a supportive environment (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010) (Gilbert, 2012).

2 – Adolescents favour short term extrinsic rewards, and in comparison to children and adults they have an exaggerated pleasure response to things they find rewarding (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) (Albert, Chein & Steinberg, 2013).
3 – Adolescents place significant value on status with their peers (Gilbert, 2012) (Somerville, 2013). Losing peer status is a significant threat that can paralyse learning, gaining peer status is significantly rewarding.

4 – Prior learning based on stereotypes and incorrect facts is a barrier to new and correct learning. Incorrect prior learning can be persistent, even in response to positive corrective action (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010).

5 – Adolescents have difficulty considering second and third order effects, they lack impulse control, an understanding of risk, and are drawn towards novel activities; particularly in the presence of their peers (Blakemore, 2012) (Casey & Caudle, 2013) (Viding, McCrory, Blakemore, & Frederickson, 2011). Accordingly, the application of consequences or punishment for bad behaviour is likely to be less effective than the preventative mechanisms associated with supervision, guidance and mentorship.

6 – Supportive and controlled emotional environments promote adolescent learning, and any emotion can hijack rational thought (Gilbert, 2012) (Spear, 2000).

7 – Adolescents have a reduced capacity for empathy (Blakemore, 2012) (Viding, McCrory, Blakemore, & Frederickson, 2011) and accordingly have difficulty viewing a situation from any perspective other than their own. Learning should shaped from their own perspective, not how it ‘feels’ to be someone else.

8 – Physical fitness improves cognitive ability and mental health (Jensen, 2008) (Medina, 2012).

9 – Adolescent behaviour is not necessarily predictive of future adult performance. Much like physical maturity, myelination of the brain is a biological process that can’t be accelerated through education. However, establishing the right foundations and neural pathways during adolescence may shape future adult behaviour.
This chapter will consider the application of these proposed adolescent learning factors at ADFA to develop adolescent learning strategies specifically tailored for the demographic of 17 to 23 year olds within a residential military officer training establishment.

**Defining the Parameters of the Learning Environment**

In the context of ADFA, an effective adolescent learning strategy has to consider more than just the classroom. Much of the required learning for a new officer trainee is based around personal values and attributes, and in many cases the acquisition and application of new personal standards of behaviour that are considered appropriate in the military context. These new behavioural expectations extend beyond the classroom and into residential, sporting and social environments, inclusive of social media. Accordingly, an effective adolescent learning strategy must also extend beyond the classroom and into these environments.

In defining the parameters of the adolescent learning environment, it is also important to provide a theoretic boundary between the concepts of ‘education’ and ‘training’. ADFA provides both education and training to the midshipmen and officer cadets. For the purposes of this thesis, ‘education’ is conducted to prepare trainees to deal with uncertainty, and it provides the trainee with knowledge and mental acuity enabling independent thought and problem solving. In contrast, ‘training’ is conducted to prepare the midshipmen and officer cadets for certainty. For example, conducting the many intricate hand and foot movements associated with a ceremonial parade does not require independent thought or problem solving. It is a drill that requires a specific action to be provided in response to a verbal command. In developing adolescent learning strategies for ADFA, the focus is in relation to education rather than training. It may transpire that the military subjects that require a higher
degree of cognitive ability such as Leadership and Military Communications may have a more significant result from the application of adolescent learning strategies than subjects such as Drill or Physical Training.

**Adolescent Learning Strategy**

As discussed in previous chapters, educational psychology and constructivism suggests that ‘learning’ and a deep conceptual understanding requires learners to spend considerable time and effort thinking about concepts, exploring the relationships among concepts and applying the concepts to the external world. This type of learning requires considerable mental effort, and like any other application of effort (such as physical effort), it is fuelled by motivation. Proponents of adult learning theories have suggested that adult learners provide their own motivation for learning. Neuroscientific research has suggested that adolescent brain function is different in comparison to adults and accordingly, it may be reasonable to postulate that their motivation to learn may also be different. Ambrose, Bridges, Lovett, Di Pietro and Norman have suggested that the motivation to learn is premised on three important and interrelated factors: the student’s sense of value in relation to the learning, a high expectation of success, and the provision of a supportive environment (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010).

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<th>Unsupportive Environment</th>
<th>Supportive Environment</th>
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<td>Student’s sense of value is:</td>
<td>Don’t see Value</td>
<td>See Value</td>
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<tr>
<td>Student expectation of achievement is:</td>
<td>Low</td>
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<td>High</td>
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Table 1: Interactive effects of Environment, Expectation, and Value on Motivation (recreated from: Ambrose, Bridges, Lovett, DiPietro & Norman, 2010).
In constructing a suitable adolescent learning strategy, this work will consider what current research suggests in relation to adolescents’ sense of value, their expectation of success and the creation of supportive environments, and then recommend learning strategies specifically for ADFA.

**Value.** In relation to the issue of value, this study has previously identified that adolescents have an exaggerated response to reward stimuli in comparison to children and adults, and that they tend to favour short term extrinsic rewards rather than those that are longer term or intrinsic (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006). This would suggest that adolescent learners may lack sufficient motivation to learn for the sake of attainment value (satisfaction of accomplishment) or intrinsic value (satisfaction from doing the task) and may require something of more instrumental or extrinsic value. This may suggest that adolescent learners are less likely to value learning that isn’t being marked or assessed. If they know it isn’t going to be marked or assessed, they are unlikely to value the learning for attainment or intrinsic value. Accordingly, to ensure that learning has value for adolescent learners, ADFA should ensure that everything they want to have learnt is assessed to give it a degree of extrinsic value.

Although ensuring that learning is being assessed is important to give it a sense of value in the eyes of adolescent learners, the degree of value that is attributed to the learning may be variable in relation to the type of extrinsic reward that is linked to the learning achievement. For example, providing a 50% pass mark for a learning event may provide enough extrinsic value for 51% effort. Prior to the conduct of this research ADFA implemented a new policy for the award of commendations to reward excellent performance in either academic or military fields of study. When awarded, these incremental Deputy Commandant and Commandant...
commendations are worn on the uniform of the recipient as a physical representation of their achievement. Staff at ADFA attribute these commendations with changing the attitude of the students from ‘51% being one percent wasted effort’ to a situation where 80.8% of the trainees were in receipt of an academic or military commendation in 2011 (ADFA, 2011). The success of this program can probably be attributed to the fact that the commendations represented a short term extrinsic reward that elevated peer status, and accordingly the adolescent demographic attributed them with significant value. This research has previously queried the Kafer Review recommendation not to reintroduce a cadet hierarchy at ADFA however, if properly guided and mentored by staff, it is likely that a cadet hierarchy would be a very effective and motivational short term, extrinsic reward linked to peer status.

The military has a culture associated with providing awards and medals for actions that are considered ‘above and beyond the call of duty’, and in some instances this can lead to an environment where personnel are not praised for ‘just doing their job’ or even for doing their job well; it is an expectation that everyone will do their best. However, when motivating adolescents it is likely that immediate public praise for demonstrations of desired behaviours would be effective at encouraging a continuance of that behaviour because it is immediate, extrinsic and potentially elevates their status with their peers (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) (Albert, Chein & Steinberg, 2013) (Gilbert, 2012) (Somerville, 2013). The staff at ADFA should be encouraged to provide regular immediate public praise in response to demonstrations of desired behaviour.

The importance of intrinsic value shouldn’t be entirely dismissed from an adolescent learning strategy just because research suggests that adolescent favour extrinsic rewards. Research suggests that adolescents are reward driven (Galvan, Hare, Parra, Penn, Voss, Glover & Casey,
(Albert, Chein & Steinberg, 2013), the key to tapping into their intrinsic motivation may be to find imaginative ways of making learning fun and enjoyable so that the value comes from participating in the learning event. Identifying intrinsic motivation is likely to be more focused on the individual trainee rather than a group. For example, the athletic student is likely to get more intrinsic motivation from a physical lesson than a student who is less athletically inclined.

**What is valued.** Some of what the trainees at ADFA attribute with value will be based on prior learning. Whether learnt from relatives or friends with military experience, from television programs or movies, books or urban legend, each trainee at ADFA has a preconceived idea about military service that was appealing enough for them to want to enlist. In many cases the prior learning that has occurred is based on incorrect or outdated information and is often linked to the stereotypical image of service personnel – fit, male and Anglo-Saxon. For those that fit this mould, a continuance of the stereotype and associated value is appealing because it potentially elevates their peer status and personal sense of value. Because their prefrontal cortex has not fully myelinated (Blakemore, 2011), the adolescent demographic may have a diminished ability to empathise (Wolfe, 2010) with those that might not fit this mould. For that reason minority groups based on gender, race, religion, sexual orientation or lower fitness level (whether by genetics or injury), are potentially seen by the adolescent mind as having less organisational value. To address these issues very early in the training sequence, ADFA should develop a program that is designed to remediate incorrect prior learning. It should also be remembered that research has shown that incorrect prior learning is persistent, even in response to direct corrective action (Ambrose, Bridges, Lovett, DiPietro & Norman, 2010). Accordingly, it often takes considerable time to make changes, and failures are common throughout the process. For this reason it is likely that ADFA will continue to have behavioural incidents in spite of positive corrective action. Behavioural incidents that are linked to a lack of

**Expectation of success.** All of the available evidence suggests that ADFA does not have any systemic problems associated with trainees’ expectation of success. In 2011 the student attrition rate was only 7% (ADFA, 2011). However, understanding this aspect of overall student motivation may help ADFA staff to manage certain individuals who are having difficulty. There is no potential for motivation if a student has a low expectation of success (Ambrose, Bridges, Lovett, Di Pietro & Norman, 2010). If a student is failing to meet the required standard or has a low expectation of success, the underlying problem is likely to be: a lack of ability, a lack of effort, a lack of focus or distraction, incorrect prioritisation, personal problems, or health problems. In order to improve the motivation of a trainee experiencing problems, ADFA should have a method of addressing the underlying problem and improving the trainee’s expectation of success. In this regard, the root cause of problems mentioned above can largely be placed into two categories: those within the student’s control, and those outside the student’s ability to control. Those issues that are outside of a student’s ability to control such as lack of ability, personal problems and health problems, require an administrative approach to provide a support mechanism such as additional tuition, a change of course, medical or philanthropic support. Those problems that are within the student’s ability to control may require a different strategy that recognises the strengths and limitations of the adolescent brain.
Research suggests that adolescents prefer immediate gratification and short term rewards (Galvan, Hare, Parra, Penn, Voss, Glover & Casey, 2006) (Albert, Chein & Steinberg, 2013). Accordingly it is not surprising that some adolescents have difficulty prioritising or placing work requirements before what they find fun and immediately enjoyable. This is particularly evident in the presence of their peers where the Ventral Striatum rewards them with dopamine for participating in novel activities (Blakemore, 2012) (Casey & Caudle, 2013) (Viding, McCrory, Blakemore, & Frederickson, 2011). Adolescents who are suffering from a lack of self-discipline around work or study requirements may require additional guidance and mentorship to reinforce their personal discipline and help them overcome the limitations of their brain’s immature reward mechanism. Leave limitations, enforced study periods and extra-curricular restrictions may be effective mechanisms to provide a scaffolding around better performance and an increased expectation of success. It is important to note that research suggests that a lack of self-discipline during adolescence is not necessarily indicative of future adult performance.

Supportive environment. According to Ambrose, Bridges, Lovett, Di Pietro & Norman (Table 1), a supportive environment is important in order to foster motivated learners. In comparison to other universities, ADFA has arguably one of the best networks of support personnel (Chain of Command, after hours duty officers, medical, physiotherapy, psychologists, legal officers, religious staff, equity advisors) of any residential college in Australia. However, the Grey, Kafer and Broderick Reviews all refer to an issue of ‘us and them’ or a failure to ‘cross the road’ where trainees are resistant to raise issues of concern with the staff. In spite of all of the support mechanisms available, the trainees don’t seem to want to use them, and accordingly, may feel unsupported. It is possible that the contemporary research into adolescent brain
Both the established literature on educational psychology and the more recent literature on adolescent brain development refer to the term ‘scaffolding’. In educational psychology, scaffolding is synonymous with guidance provided by a more knowledgeable, and often more senior, person (Collins, Brown & Newman, 1989; Hmelo-Silver, Duncan & Chinn, 2006; Hogan & Pressley, 1997; Wood, Bruner & Ross, 1976). This scaffolding can be provided in person, as the learner is engaged in learning activities, or it can be designed into the environment, ie. via cues and clues included in the learning materials. In-person scaffolding may include didactic teaching via direct instruction, modelling, coaching and mentoring. Part of its purpose is to guide the development of skills and understanding via demonstration, observation, feedback and discussion. Another part of its purpose is to motivate and maintain the learner’s engagement in learning via encouragement, contextualisation and even inspiration. It has many of the features of leadership, but with a developmental or educational focus. Over time, as the learner’s competence develops, the scaffolding is gradually ‘faded’ until the learner is acting independently, without any scaffolding. Apprenticeship is an exemplar of learning via in-person scaffolding. The apprentice learns by working alongside a more experienced professional and the professional’s task is to develop the apprentice, in addition to completing the work. As trust in the apprentice’s competence grows, more and more opportunities are provided for the apprentice to work without close supervision, until the day comes when the apprentice graduates as a fully-qualified professional.
The adolescent brain development literature focuses more on social scaffolding to help guide or regulate the behaviour of adolescents until their capacity to self-regulate is adequately developed (Dahl, 2004; Masten, 2004).

This term *scaffolding* ... refers to individuals and social structures that provide support, constraints, and monitoring of youth. Typically, this includes parents, teachers, coaches, schools, communities, and most importantly, the rules and behaviours of the adults that provide monitoring and a “safety net” for adolescents. (Dahl, 2004: pp.294-295)

The adolescent brain development literature treats scaffolding as a means of regulating adolescent behaviour until brain development allows those adolescents to self-regulate without scaffolds. The educational psychology literature sees scaffolding as part of a more active process which challenges learners to do new things and shapes the development of new knowledge and skills. This difference may just reflect the disciplinary origins of these literatures and the practical concerns of their authors. The adolescent brain development literature, drawing on MRI studies, originates in health and medical research, many of the authors are concerned about protecting adolescents from dangers and health risks, and they see scaffolding as a means to restrain risky adolescent behaviour. The educational psychology literature focuses on extending human capabilities through learning, and it sees scaffolding as a means of developing and shaping learners’ skills and understanding. One sees scaffolding as providing constraints, the other as providing enablers. It is possible for scaffolding to do both at once, but each implies a different relationship between the person providing the scaffolding and the adolescent who is being either constrained or enabled.
This raises the question of whether the support in the environment at ADFA is primarily constraining or primarily enabling. Both types of support are intended, but the perceptions of adolescent trainees suggest that they feel more constrained than enabled.

Military command is based on the legal authority to issue orders and the responsibility associated with the ‘morale, welfare and discipline’ of subordinates. It is the focus of the military chain of command on ‘discipline’ that may be fracturing the premise that ADFA is a supportive environment in the eyes of the adolescent trainees. The Grey Review in particular notes that the trainees view the staff as being ‘evaluators, disciplinarians and judges’ and likened their feelings to be similar to that of a ‘prisoner’s view of the prison staff’ (Grey, 1998).

The adolescent view of the military staff as gaolers may be influenced by their brain function. Due to the lack of myelination in the prefrontal cortex, adolescents have a diminished capacity for empathy, or the ability to view a situation from someone else’s perspective (Blakemore, 2012) (Viding, McCrory, Blakemore, & Frederickson, 2011); in this instance the views and intentions of the military staff at ADFA. Accordingly, the adolescent view of the world is potentially very self-centred. Additionally, the adolescent amygdala, responsible for threat detection, has completed myelination and is capable of processing significantly more information than the prefrontal cortex (Steinberg, 2014) (Wolfe, 2010). In a manner, this enables the amygdala to hijack the executive decision making and rational thought of the prefrontal cortex in response to a perceived threat or other emotional stimuli (Casey & Caudle, 2013). While the military staff have a role in discipline, and the discipline is viewed as threatening, adolescent decision making is likely to remain in the amygdala and characterised by a fight, flight or freeze response. It is also very likely that the adolescents will be viewing military staff through the perceptions established over a lifetime of prior learning and military
stereotyping that may or may not reflect the reality of staff approachability. In order to address the issues associated with trainees ‘crossing the road’ and viewing the staff in a more supportive capacity, ADFA would have to reduce the threat that trainees associate with staff. This could be achieved by limiting the disciplinary role of certain staff within the chain of command or reducing the severity of punishments available to staff. Interestingly, the premise of this approach was recommended by both the Grey Review which states that ‘...cadets must have access to informed and non-judgemental guidance’, and the Broderick Review which suggests that ‘These Residential Advisors could be encouraged to...provide informal guidance and support to cadets’. Many ADFA staff are professional military officers and ADFA trainees will soon join their ranks as fellow officers. There is potential, here, for an apprenticeship-style relationship to be fostered, using scaffolding as an enabler to shape cadets’ learning, but it may require changes in the ways that ADFA’s officers interact with those cadets. An approach that focuses on coaching and mentorship rather than consequence and punishment would help to reduce the threat the students associate with the staff and may increase their desire to access support by ‘crossing the road’.

In many situations, the punitive actions associated with military administrative and disciplinary action could detract from the trainee’s expectation of success and accordingly impact their motivation to learn. An alternate or complementary approach could be to ensure that every adolescent being disciplined is provided with a ‘roadmap to recovery’. This roadmap to recovery would ensure that adolescents could still be disciplined and held to account, but would ensure that they are supported with a process that would return them to their original status through a series of attainable positive actions or gateways along the way. This approach would promote a sense of value attributed with each of the gateway events, and potentially correlate with the adolescent brain’s exaggerated response to reward stimuli, and the value
attributed to both extrinsic rewards and peer status. Ultimately, these recommendations are attempting to remove the sense of threat (real or perceived) that the midshipmen and officer cadets associate with staff, and ensure that even when they are being held to account through disciplinary action, they feel supported. From one negative behavioural event there could be multiple positive performance gateways required on the ‘road map to recovery’. These positive performance gateways would provide a correlation between positive behaviour and reward, and produce a scaffolding for neural pathways that would influence future behaviour, and reinforce the existence of a supportive environment.

The provision of a supportive environment at ADFA should not just focus on the threats the midshipmen and officer cadets perceive from the military staff. Research has suggested that adolescents value status with their peers above most other things (Gilbert, 2012) (Somerville, 2013). Accordingly, the potential for a loss of status amongst their peer group, should be one of the threats that an effective adolescent learning strategy should try to minimise in order to provide a supportive environment.

The questioning technique taught to military instructors may be one example of a threat to peer status. In the ADF instructors are taught a questioning technique based on: question, pause, nominate. This proposes the question, provides a pause for all trainees to consider the answer, and then nominates the person expected to provide the answer. Rather than asking for someone to volunteer an answer, this technique aims to ensure that everyone is paying attention and is suitably prepared for the lesson. Although this may be a suitable technique for testing rote learnt information, it may be less effective for answers requiring more cognitive effort or processing such as exploring the relationships between different concepts and constructing original thoughts. Being ‘nominated’ to provide an answer to a complex question...
in group environment might be more threatening to an adolescent because they could perceive that they are being judged by their peers on their ability to think and their thoughts rather than just their memory as may be the case in relation to rote learnt information. A less threatening environment may be to allow adolescents to discuss concepts in small groups and provide a group response. Being able to say ‘we think...’ instead of ‘I think...’ may remove the threat associated with being personally judged and promote a more supportive learning environment and greater classroom engagement.

**Physical fitness.** Research has suggested that there is a direct link between physical fitness and mental health and improved cognitive ability (Jensen, 2008) (Medina, 2012). ADFA has world class physical training facilities, dedicated physical training staff, and a physical training program that recognises the demographic is physically immature and gradually introduces trainees to aerobic fitness, strength and conditioning training. However, in the same manner that some trainees are less ‘academic’, some trainees are less ‘physical’ and lack the intrinsic motivation for physical training. It is likely that some of these trainees feel threatened by this environment because of the importance that the military places on physical fitness and they may feel that poor performance will result in a lack of peer status. Although it is important to recognise that the military has minimum standards of performance that must be met, it may be possible to reduce the threat associated with the environment by conducting ability based training, where trainees of similar physical capability train together.

**Applied adolescent learning strategies**

Specific adolescent learning strategies applied by ADFA during the implementation period included:
1. Formal assessment of all military subjects to provide a sense of extrinsic motivation.
2. Commendations for military and academic performance to reward behaviour and elevate peer status.
3. Introduction of bi-annual open forum discussions regarding training development to increase engagement and sense of value.
4. Introduction of mandatory Individual Leadership Projects to promote peer leadership and associated peer status.
5. Linking local leave entitlements to performance to provide extrinsic motivation.
6. Posing questions to small groups rather than individuals to reduce fear and increase cognitive engagement.
7. Increased supervision by staff to provide a supportive environment and moderate behaviour.
8. Introduction of live-in Residential Advisors to provide a supportive environment and moderate behaviour.
9. Introduction of Officer Cadet mentor programs to provide a supportive environment and peer status.
10. Improved staff selection process (mentors, not disciplinarians).
11. Improved staff training in relation to adolescent learning.

**Summary of Chapter 4**

A review of contemporary research literature on adolescent brain development and educational psychology has raised a number of potential incompatibilities between adolescent learning and the model of andragogy advocated by Knowles (1980) and recommended for ADFA by both the Grey and Kafer Reviews. The same literature review revealed nine ‘factors’ which appear to be particularly important for adolescent learning. These factors were used to
develop 11 specific changes which comprise ADFA’s adolescent learning strategy. These changes were implemented through the 2011-2013 period. The method used for evaluating the effects of ADFA’s adolescent learning strategy will be discussed in the next chapter.
Chapter 5 - Method of investigation

The aim of this chapter is to define the methodology that will be used to analyse the adolescent learning strategy implemented by ADFA in order to address the following question:

Can an adolescent learning strategy improve the learning experience of 17-23 year old learners in an establishment such as ADFA?

In order to answer this question there must be some research parameters established. First it is necessary to define what is meant by the ‘learning experience’ and develop a tool through which it can be measured. Secondly the ‘learning experience’ must be measured prior to, and after, the application of the new adolescent learning strategy through a research mechanism appropriate to consideration of changes over time. This requirement presents some significant challenges in collecting data to answer the research question, and limits the options available for the conduct of research.

For the purposes of this research, the ‘learning experience’ might be operationalised as a combination of trainee engagement, trainee satisfaction, quality of instruction, and demonstrated achievement of the learning objectives. In order to measure the ‘learning experience’ there needs to be data available to evaluate the opinions of the trainees, and their performance. In an ideal research circumstance measuring the ‘learning experience’ would benefit from the observations of military staff members, particularly given that much of the ‘demonstrated achievement of the learning objectives’ is values and attitudes based, and in a military academy is assessable in a much broader context than simply considering exam results and should also include residential, social and sporting environments. Equally, a detailed
consideration of the ‘demonstrated achievement of the learning objectives’ including discipline statistics and other data relating to trainee performance and behaviour would have been advantageous. Unfortunately, data in relation to trainee academic results, discipline statistics and quality of instruction was not available for this research.

The most significant challenge in relation to answering the research question is in relation to the missed opportunity to evaluate the impacts of the adolescent learning strategy over the period that it was being implemented. ADFA commenced investigating the possible requirement for a new pedagogy in relation to military training in 2011, and had formalised (although not finalised) an approach to military training based on an adolescent learning strategy by the beginning of 2013. Although a specifically tailored research survey may have been the best method for measuring the attitudes or opinions (Neuman 1999) of the trainees and staff towards an adolescent learning strategy, the opportunity to conduct such research had passed.

With the inability to conduct a tailored research survey, different data was required for the conduct of ‘longitudinal research’ (Neuman, 1999). Fortunately, throughout the adolescent learning strategy implementation period, ADFA’s internal training review process captured data that could be used as indicators of student satisfaction and student engagement. The internal training review was conducted biannually, by trainee year level at the conclusion of each academic session through an online tool called SurveyMonkey®. The internal training review was structured with questions specific to each military subject. Trainees could enter a response on a Likert scale for each ‘closed-ended’ question. They were also invited to expand on their responses with additional comments in a more ‘open-ended’ fashion (Neuman, 1999). The internal training reviews, conducted every 6 months, yielded large sets of both
quantitative and qualitative data which can be used to address the research questions in this case study. Ethical approval to use the internal trainee review data for this research was provided by the Defence People Research – Low Risk Ethics Panel – Protocol 071-15.

Although the internal training reviews provided an excellent source of data, the research requirement to measure results over time must give serious consideration to the continually changing population of trainees and instructors throughout the implementation period. The military curriculum at ADFA is three years in duration and at any one time there are Midshipmen and Officer Cadets in first year, second year and third year undertaking training. Accordingly, throughout the period that ADFA was implementing the adolescent learning strategy from 2011 to 2013, there were five different generations of trainees who experienced varying levels of the new training strategy (Table 2). However, one student cohort (Generation C) was present during the entire implementation period.

<table>
<thead>
<tr>
<th></th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Gen C</td>
<td>Gen B</td>
<td>Gen A</td>
</tr>
<tr>
<td>2012</td>
<td>Gen D</td>
<td>Gen C</td>
<td>Gen B</td>
</tr>
<tr>
<td>2013</td>
<td>Gen E</td>
<td>Gen D</td>
<td>Gen C</td>
</tr>
</tbody>
</table>

Table 2 - ADFA Generations during implementation of adolescent learning strategy 2011-2013.

Additionally, ADFA’s instructional staff continually changed throughout the implementation period due to the regular three year posting cycle and other influences. As a result of the fluid population of trainees and instructional staff throughout the period that ADFA was designing and implementing an adolescent learning strategy, a ‘panel study or cohort analysis’ would be an ineffective research approach however, ‘time-series research’ would provide a ‘longitudinal analysis’ of the generic effect of an adolescent learning strategy on ADFA trainees (Neuman, 1999).
In consideration of the research question and the factors influencing the available data, the research method to be used will be a secondary, time-series longitudinal analysis of quantitative and qualitative existing data.

**Evaluating the suitability of available data**

The principal source of data for the conduct of this research will be the internal training reviews conducted by ADFA. These reviews were conducted biannually, by year level, after each of the two academic sessions and accordingly there are 6 data sets per year and 18 data sets for the period of this research 2011-2013 (Table 3).

<table>
<thead>
<tr>
<th>ADFA Internal Training Review Data Sets (DS)</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1 Session 2 Session 1 Session 2 Session 1 Session 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Year DS 1 DS 4 DS 7 DS 10 DS 13 DS 16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Year DS 2 DS 5 DS 8 DS 11 DS 14 DS 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Year DS 3 DS 6 DS 9 DS 12 DS 15 DS 18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 – ADFA Internal Training Review Data Sets (DS).

In assessing the suitability of the data from the training reviews consideration needs to be given to the sample size in reference to the population (Neuman, 1999). For the purposes of conducting research it has been proposed that ‘the smaller the population, the bigger the sampling ratio has to be for an accurate sample’ (Neuman, 1999), and that for a population of under 1000, the sample ratio should be no less than 30%. The population of trainees undertaking training at ADFA is a dynamic figure that is influenced by voluntary and involuntary separations of the trainees from service in the ADF, and accordingly, it is difficult to baseline this dynamic population. For the purposes of determining the sample size, the population of ADF has been based on the annual recruitment targets for ADFA by each
service. Considering the recruitment targets for ADFA in 2011 were 64 for the RAN, 160 for the Australian Army and 104 for the RAAF, the start point of each first year class is a total of 328 students. The number of respondents to each one of the data sets and the corresponding percentage of the population of 328 is provided at Table 4.

<table>
<thead>
<tr>
<th>ADFA Trainee response rate</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Session 1</td>
<td>Session 2</td>
<td>Session 1</td>
</tr>
<tr>
<td>1st Year</td>
<td>49 (14%)</td>
<td>105 (32%)</td>
<td>283 (86%)</td>
</tr>
<tr>
<td>2nd Year</td>
<td>24 (7%)</td>
<td>125 (38%)</td>
<td>229 (69%)</td>
</tr>
<tr>
<td>3rd Year</td>
<td>60 (18%)</td>
<td>155 (47%)</td>
<td>230 (70%)</td>
</tr>
</tbody>
</table>

Table 4 – ADFA ‘Population’ response rate to internal training review.

The relatively high response rate can be attributed to the fact that ADFA is a ‘special population’ (Neuman, 1999), and as military personnel the students were expected to attend the period during which the survey was conducted. It is important to note that these surveys were anonymous, and that no trainee was ‘ordered’ to provide any responses for the purpose of this research. The less than 100% response rate can be attributed to members of the original population having discharged, members being absent on other duties, sick or disengaged trainees using the anonymity of the survey responses to not complete the questions. Having established that only three of the eighteen data sets are of insufficient response rate, (2011 Session 1 data sets) and that the remaining fifteen data sets analysed represents a response rate of at least 30%, the sample size is considered suitable for the conduct of the research.

In addition to commencing a review of the training packages and learning strategy in 2011, ADFA also commenced conducting open forum discussions with the trainees. These open forum discussions were held after the survey results had been analysed, and presented the
opportunity for the staff to provide feedback to the trainees. The main purpose of the open forum discussions was to explain what was going to be done to address problems that were identified, provide an explanation for why issues raised by the trainees would not be addressed (for example, a lack of resources), or seek clarification or more detail on an issue that was raised. The open forum discussions appear to have added significant value to the data being collected because the trainees could see that their input was valued and being used to make positive changes to the training program. By validating the contributions the ADFA staff established a greater rapport and trust (Neuman, 1999) with the trainees.

All of the 18 internal training reviews were conducted anonymously through the online SurveyMonkey® tool. Although there was some data captured relating to the gender and service of the participants, there was insufficient information gathered to enable the respondents to be identified. This anonymous method of data collection maximised the opportunity to review honest feedback free from reprisal, with regards to developments with the training package. This anonymous approach to surveying the ADFA population is seen as being particularly important given that ADFA is a military training establishment, and the trainees may have been guarded with the truth had their responses been attributable to them by their superior officers.

The internal training reviews produce significant quantity of data for analysis. Although the volume of data is less important than the quality of the data, comparison of the amount of data produced over the research period in Table 5 has produced some interesting facts. Despite the surveys containing less pages of questions in 2012 than in 2011, the amount of written responses increased. This is seen to be further evidence of the importance of the open forum discussions held by the ADFA staff in increasing the value the trainees placed on the
information they provided during the internal training reviews. The higher response rates are a measurable indication of the level of engagement being demonstrated by the trainees and are directly linked to the ‘positive learning experience’ being examined by the research question.

Table 5 – Volume of data available.

In assessing the quality of the data produced by the internal training reviews it is important to evaluate the quality of the review questionnaires. Each of the questionnaires has been tailored to specifically address the training program of a specific six month period within a three year training continuum. Although some of the questions are common, many of them are not, and when considering some of the Data Sets have approximately 100 questions, and there are a total of 18 Data Sets, at the extreme end of the scale there are possibly 1800 different questions that have been asked of different respondents throughout the training review process. Accordingly, it is necessary to make a more generic assessment of the quality of the internal training review questionnaires.
In analysing all of the questionnaires it becomes apparent that there is specific period of change from the style of questionnaire from 2011 to 2012. Although questionnaires from both periods structure the questions around military subjects such as Leadership, the questionnaires from 2011 have some differing questions for each military subject and up 24 questions per subject. By comparison, the questionnaires in 2012 and 2013 have adopted a standard series of four questions for each military subject. The different questions asked of 2011 and 2012/2013 for the military subject of Leadership have been presented in Table 6 for comparison.
Table 6 – Comparison of Internal Training Review ‘Leadership’ Questions

<table>
<thead>
<tr>
<th></th>
<th>2011 Questionnaire</th>
<th>2012/2013 Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The leadership program was intellectually challenging.</td>
<td>The content of the training flowed logically</td>
</tr>
<tr>
<td>2</td>
<td>The leadership program required me to solve complex problems</td>
<td>The content was pitched at the right level</td>
</tr>
<tr>
<td>3</td>
<td>The leadership program workload was demanding</td>
<td>The instructor displayed sound knowledge of the topic delivered</td>
</tr>
<tr>
<td>4</td>
<td>The leadership program provided physically demanding challenges</td>
<td>The instructor provided opportunities for class participation</td>
</tr>
<tr>
<td>5</td>
<td>The leadership program developed my leadership skills</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>The leadership program helped build knowledge and skills that will be valuable for my future career</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The content in the leadership program was interesting</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The leadership program is an important part of my training at ADFA</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>It is important for me to perform well in the leadership program</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>The instructors delivering the leadership program had a good knowledge of their topic</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The leadership topics were delivered in a way that made the subject matter interesting</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>The instructor used a range of multimedia when delivering their leadership topics</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>The leadership training was generally delivered in an appropriate venue</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>The leadership program involved an appropriate amount of practical training</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>The leadership program involved an appropriate amount of theoretical training</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>The method used to assess my performance on the leadership program was appropriate</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>My performance on the leadership program was assessed fairly</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>I like to be assessed on my performance in leadership because it gives me an indication of my progress on the course</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Grading my performance helps motivate me to perform well in leadership</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>I understand how my performance is assessed in leadership</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>I received useful feedback on my progress in this course</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>There was support available if I needed assistance with my leadership work</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>I felt I could ask for help if I needed assistance with my leadership work</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>The help I received with my leadership work was useful and constructive</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 – Comparison of Internal Training Review ‘Leadership’ Questions.

Neuman (2000) suggests that there are ten frequent errors to avoid when structuring questions for research. These are:

1. Avoid jargon, slang and abbreviations.
2. Avoid ambiguity, confusion and vagueness.
3. Avoid emotional language and prestige bias.
4. Avoid double-barrelled questions.
5. Avoid leading questions.
6. Avoid asking questions that are beyond respondents’ capabilities.
7. Avoid false premises.
8. Avoid asking about future intentions.
9. Avoid double negatives.
10. Avoid overlapping or unbalanced response categories.

When assessing the questions used by ADFA’s internal trainee review process in Table 6, it is apparent that many of the questions reflect Neuman’s list of ten frequent errors. It is possible to characterise most of the questions asked as: ambiguous, vague, leading, or requiring the respondents to answer questions beyond their capabilities (or more appropriately, beyond their qualifications or experience). Although the internal training review questions do not always represent examples of ‘best practice’ research questions, it should be noted that in the first instance these questions were linked to a Likert Scale, requiring respondents to apportion a value: ‘Strongly Agree, Agree, Disagree, Strongly Disagree, Don’t Know’ to the statement, before then inviting the respondents to provide a more detailed ‘open-ended’ answer. The values attributed to the Likert Scale provide quantitative data results whilst the ‘open-ended’ answers produce qualitative data results. Despite the problems with the questions, there is still enough data available to support the conduct of the research.
Analysis of the data

As previously discussed, the internal trainee review surveys conducted by ADFA have produced both quantitative and qualitative data for analysis. In relation to the quantitative data, the results have been mapped in Likert Scales with value attributed to ‘Strongly Agree, Agree, Disagree, Strongly Disagree, Don’t Know’ in response to the questions asked. Because the research question is focused on the ‘positive impact’ of adolescent learning strategies, all of the quantitative analysis will be targeted on an amalgamation of the results that were recorded against ‘strongly agree’, or ‘agree’ to form an overall proxy measure of satisfaction.

Longitudinal analysis of the quantitative data drawn from the trainee’s responses to closed-questions through Likert Scales has been complicated by changes to the questions asked, and changes to the military training subjects (additions to the curriculum) over the period of analysis. Because the questions asked for the 2012 and 2013 data sets are very similar, the quantitative responses for this period will be graphically depicted in tables over time. However, the most significant period of change was between the data sets of 2011 and 2012 and due to the significant difference in the questions asked, a different approach will be required. To address this problem, each of the quantitative responses to the questions asked for each data set will be generalised as an average for a specific military subject. This will provide an average ‘satisfaction’ result for the military subject that will enable a comparison over the complete time period. The limitation of this approach is that the 2012-2013 period will analysed by specific questions asked in relation to military training subjects, the 2011-2013 period will be more general. Although a limitation, the validity of this proxy measure of overall satisfaction can be evaluated informally via its consistency or inconsistency with other measures of satisfaction, such as the qualitative data discussed below.
The analysis of the qualitative ‘open-ended’ responses to questions requires a subjective assessment of each the comments made in order to measure them for the research question. The first step in this process will be to establish a Scoring Rubric which will use the qualitative data to measure both satisfaction and engagement. Evaluating each of the qualitative comments in terms of ‘positive’, ‘neutral’ or ‘negative’ experience will provide one aspect of this measurement. By also considering whether the comments made within the survey data are ‘constructive’, ‘neutral’ or ‘non-constructive’ it will also be possible to measure the level of engagement by the trainees. The Scoring Rubric developed to analyse the qualitative data from the training review surveys is presented in Table 7.
Because of the subjective nature associated with the qualitative assessment of each comment, the integrity of the data is paramount. Accordingly, each data set will be assessed independently by two research assistants. Although both research assistants will be trained to apply the Rubric to the qualitative data sets, as with any subjective assessment of qualitative data, the generality of the ratings applied by the two research assistants may be a concern (Multon, 2010). Using a process of interrater reliability will ensure the greatest possible fidelity in the final results of the qualitative assessment (Stemler and Tsai, 2008). As a technique for assessing interrater reliability, Cohen’s kappa, was designed to determine whether two

### Positive Experience (A)

The trainee has had a positive training experience and provides a recommendation for further improvement - The visiting lecturers were excellent, but it would have been better to have more Air Force representation.

### Neutral (B)

The trainee is not referring to a specific training experience however, is making a recommendation for improvement - ADFA should teach tactics.

### Negative Experience (C)

The trainee has had a negative training experience and provides a recommendation for improvement - The civilian communication instructors don't understand the military context, it would be better to have military instructors.

### Constructive Criticism (1)

<table>
<thead>
<tr>
<th>Positive Experience (A)</th>
<th>Neutral (B)</th>
<th>Negative Experience (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The trainee has had a positive training experience and provides a recommendation for further improvement - The visiting lecturers were excellent, but it would have been better to have more Air Force representation.</td>
<td>The trainee is not referring to a specific training experience however, is making a recommendation for improvement - ADFA should teach tactics.</td>
<td>The trainee has had a negative training experience and provides a recommendation for improvement - The civilian communication instructors don't understand the military context, it would be better to have military instructors.</td>
</tr>
</tbody>
</table>

### Neutral (2)

The trainee has had a positive training experience however, is not making any recommendations - Sergeant Smith was awesome.

A comment has been made however, it is irrelevant to the training environment - Nobody reads these comments anyway.

### Non-Constructive Criticism (3)

The trainee has had a negative training experience and is disrespectful or non-constructive - The Leadership challenge was great fun in spite of the idiots running it.

The trainee is not referring to a specific training experience however, is making a negative comment - The military training program is a joke.

The trainee refers to a negative training experience and is disrespectful or non-constructive - Since when did the pass mark in an exam become 80%, it is a shame the staff can’t do maths.

### Qualitative Data Results - Scoring Rubric

Table 7 – Qualitative analysis – Scoring Rubric.
independent judges would have a degree of agreement that was better than chance alone (Cohen, 1968). Each of the 7561 individual comments from the 18 Data Sets will be rated by both Research Assistants against the Scoring Rubric at table 7 to determine whether the comment is an example of:

1. 1A Constructive Criticism / Positive Experience;
2. 1B Constructive Criticism / Neutral Experience;
3. 1C Constructive Criticism / Negative Experience;
4. 2A Neutral Criticism / Positive Experience;
5. 2B Neutral Criticism / Neutral Experience;
6. 2C Neutral Criticism / Negative Experience;
7. 3A Non-Constructive Criticism / Positive Experience;
8. 3B Non-Constructive Criticism / Neutral Experience; or
9. 3C Non-Constructive Criticism / Negative Experience.

Using Cohen’s Kappa, the results from the two Research Assistants will be evaluated to ensure that interrater reliability is consistent (Hallgren, 2012).

Longitudinal analysis of both the quantitative and qualitative data will provide a measurement of changes in satisfaction and engagement throughout the implementation period in accordance with the following table:
### Table 8 – Measurement of Satisfaction and Engagement

<table>
<thead>
<tr>
<th></th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Satisfaction</strong></td>
<td><em>Likert Scales</em> (proxy measurement of overall satisfaction)</td>
<td>Percentage of positive comments</td>
</tr>
<tr>
<td><strong>Engagement</strong></td>
<td>Voluntary participation rate</td>
<td>Percentage of constructive comments</td>
</tr>
</tbody>
</table>

### Summary of Chapter 5

The application of an adolescent learning strategy within ADFA is a much wider study than merely considering the trainees’ test results over time. At its core, an adolescent learning strategy seeks to moderate adolescent behaviour to produce the most effective environment for a positive learning experience. Throughout the period 2011 to 2013, ADFA recognised some deficiencies in the training pedagogy, and commenced a program to try and improve the learning experience that was based on the age demographic of the trainees and recognised both the strengths and limitations of how the adolescent brain functions. During the period, ADFA used a system designed for internal review and improvement of the military training curriculum to help gauge the effectiveness of the adolescent learning strategy. This research methodology has reviewed the data produced by the internal training review and demonstrates that although it was not designed for purpose, it will be an effective method for secondary, time-series longitudinal analysis of the research question ‘Can an adolescent learning strategy improve the learning experience of 17-23 year old learners in an establishment such as ADFA?’
Chapter 6 - Results

During the period 2011 to 2013 ADFA implemented a new pedagogical approach to military instruction based on relatively recent research into adolescent brain development, function and educational psychology. The new approach to military instruction was based on a series of adolescent learning strategies implemented to positively impact the learning experience of trainees at the officer training establishment. For the purpose of this research, the impact of these strategies on the learning experience was measured through a secondary analysis of quantitative and qualitative responses that the trainees provided to an internal training review process. The internal training review was conducted biannually by each trainee year level and accordingly provides the opportunity for a time-series longitudinal analysis of the learning experience across 18 data sets.

<table>
<thead>
<tr>
<th>ADFA Internal Training Review Data Sets (DS)</th>
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</thead>
<tbody>
<tr>
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<td>Session 1</td>
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<tr>
<td>1st Year</td>
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<td>2nd Year</td>
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<td>3rd Year</td>
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Table 3 – ADFA Internal Training Review Data Sets (DS).

Quantitative data results

As previously explained in the methods chapter, the internal training reviews were conducted with the SurveyMonkey® on-line tool. The quantitative data results were mapped in a Likert Scale after trainees were asked to select ‘Strongly Agree’, ‘Agree’ ‘Disagree’ ‘Strongly Disagree’ ‘Don’t Know’ to a series of closed-ended questions. The results from these reviews will be presented as a percentage score that amalgamates the number of trainees that selected ‘Strongly Agree’ or ‘Agree’ as a measure of positive impact that can be examined over time.
The analysis of the quantitative data has been complicated by the change in questions that occurred between 2011 and 2012. To overcome this issue, the results for 2011 are being presented as an average percentage of the number of trainees that had a positive response for each military subject. The analysis has been further complicated by changes to the yearly programming of certain military subjects; the renaming of subjects; the discontinuation of subjects; and, the creation of new subjects. All of the results have been presented in the table below. Greyed boxes identify that there is no data for the field and are usually the result of programming changes and reflect that the subject was not conducted during that period. Highlighted yellow boxes reflect the subjects that have the most applicability to a constructivist learning model.
Table 9 - Academy Military Education and Training (AMET) program quantitative data results (numerical figure represents the percentage of students that recorded a positive response).

The figures depicted in Table 9 represent the raw quantitative results for each data set as a percentage of the students that recorded a positive response to the questions. The subjects presented in the second part of the table Barriers to Change; Positive Performance; Unhealthy Attractions; Evaluating and Understanding Personality; Defence Environment Practical; Workplace Behaviour; Healthy Relationships; and Personality Sessions, provide insufficient data for longitudinal analysis, and accordingly will not be the subject of further discussion. The subject results presented in the first part of the table are sufficient for analysis however, the

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83
manner of presentation in Table 9 does not suit time-series longitudinal analysis. Largely this is because the data set number is just an identifying label and the data sets are not always sequential.

The following table presents the quantitative data sets by academic year level and military subject over the period 2011-2013. Presenting the data in this manner represents the experience of each year level over the three different years; it is important to remember that these results reflect the experience of a different trainee generation going through the same year level training program.

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<td>3rd Year Students</td>
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<td>Equity and Diversity</td>
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<td>Weapons Training</td>
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Table 10 – AMET Quantitative Data Results by academic year and military subject (numerical figure represents the percentage of students that recorded a positive response).

Most military subjects in all three year levels have seen an improvement of the percentage of trainees reporting a positive response throughout the research period. 1st Year Customs and Traditions, Equity and Diversity, and Weapons Training, and 2nd Year Drill and Ceremonial, and Weapons Training are the only instances where the final result in 2013 was lower than the percentage recorded in 2011. However, even though these identified instances showed a decrease in positive response, the lowest result of these instances was still 74% positive.

It is worth noting, in relation to Table 10, that the annual increase in the percentage of students responding positively in 2011, 2012 and 2013 is approximately linear in each of the highlighted rows. At first glance, the redesign of the questionnaire between 2011 and 2012 seems not to have interrupted this trend. The apparent rate of improvement between 2011 and 2012, when the questionnaire was changed, is about the same as that between 2012 and 2013, when the questionnaire was unchanged. This apparent robustness might be explained by the aggregation of the responses from individual questions into a single average measure of
overall satisfaction for each student on each questionnaire. This aggregation of the data limits the options for statistical analysis to changes in proportion satisfied, but it has been a necessary step due to the redesign of the questionnaire. As questionnaire items were changed, it is likely that students’ responses to some new items might differ from their responses to old items, but average response across the whole set of items is likely still to reflect students’ overall satisfaction. Analysis of the qualitative data will be used as an independent measure to confirm that this trend is not simply due to the questionnaire’s redesign.

A targeted focus on the ‘highlighted’ subjects previously identified as having the most applicability to a constructivist learning model is presented in the following table. This table provides a graphical representation of the amalgamated percentage of trainees who provided positive responses to the questions throughout the implementation period of the adolescent learning strategies.

![Quantitative Data - Constructivist Subjects](chart)

- **Leadership Studies**
- **Military Communications**

**Table 11 – Quantitative results for Leadership Studies and Military Communications.**
Table 11 shows that trainee satisfaction results for Leadership improved by: 28.5% in 1st Year, 25.5% in 2nd Year and 21% in 3rd year. Trainee satisfaction results for Military Communications improved by: 22.5% in 1st Year, 31% in 2nd Year and 30.5% in 3rd Year.

**Cohort Analysis.** In the interest of being thorough, the quantitative data was also analysed through the lens of a cohort analysis. Although this cohort analysis complemented the longitudinal analysis by military year level, it is presented in appendix 1 for completeness.

**Qualitative Data Results**

In addition to the close-ended questions asked during the internal trainee reviews, the midshipmen and officer cadets were also given the opportunity to provide additional information in response to open-ended style questions. It is important to remember that it was not compulsory to complete the open-ended questions. Accordingly, all analysis of the qualitative data must consider that it does not represent a known percentage of the surveyed population, and inferences and determinations must be balanced against the quantitative data which was completed by 100% of those surveyed.

Across the 18 data sets the answers to open-ended questions produced 7561 individual qualitative responses. Interestingly, Table 5 highlights a significant increase in the volume of open-ended responses towards the end of the research period despite the numbers of questions remaining relatively similar. It is also important to remember that the Methods Chapter confirmed that the questions asked by the survey did not change from 2012-2013, so the increase in volume cannot be attributed to a change in questions requiring a longer
answer. It is likely that the greater volume of response is a measurable indication of the level of engagement being demonstrated by the trainees.

Table 5 – Volume of data.

To ensure that the analysis of the qualitative data remained unbiased, two research assistants were trained in the application of a scoring rubric that was discussed in the Methods chapter. This scoring rubric (replicated below) was designed to identify whether the comment reflected a positive, neutral or negative training experience, and also whether the comment was considered constructive, neutral or non-constructive.
Both of the Research Assistants took approximately 50 hours to review and score all 7561 qualitative responses. Because of concerns regarding generality of the ratings applied by the two Research Assistants (Multon, 2010) a process of inter-rater reliability has been applied to ensure the greatest possible fidelity (Stemler and Tsai, 2008). Observed consistency between raters in this study is 60.28%, while the hypothetical chance of agreement was 1/9 or 11.11%. Using Cohen’s Kappa ($\kappa$) to assess inter-rater reliability, we can calculate that:

$$\kappa = 1 - \frac{(1 - p_o)/(1 - p_e)} = 1 - \frac{(1 - .60)/(1 - .11)} = .55$$
This is at the upper end of Landis’s & Koch’s (1977) ‘moderate agreement’ band, .40 – .60, and in the middle of Fleiss’s (1981) ‘fair to good agreement’ band, .40 – .75. Despite this level of inter-rater reliability, in order to facilitate the conduct of time-series longitudinal analysis, a single result was required. Accordingly, the 39.72% of qualitative comments that were scored differently by the two Research Assistants were coalesced.

Coalescing the differing scores of the two Research Assistants required another assessment to be made. To ensure that the data remained unbiased, the final determination was more ‘mathematical’ than subjective to avoid the potential for bias. Where the two scores given were opposite on one or both axes, for example: 1A Constructive Criticism/Positive Experience versus 3C Non-Constructive/Negative Experience; the final rating selected was Neutral to ensure that the opposite scores did not influence the results in any particular direction; in this instance 2B. Where the results on one or both axis were adjacent, for example: 1A Constructive Criticism/Positive Experience versus 1B Constructive Criticism/Neutral Experience; the final rating selected was the most conservative or closest to Neutral; in this instance 1B. Although this may have resulted in a higher representation of neutral results, it was considered a necessary requirement to maintain the integrity of the data.

The following table presents the qualitative data sets by academic year level and rubric score over the period 2011-2013. Presenting the data in this manner represents the experience of each year level over the three different years; it is important to remember that these results reflect the experience of a different trainee generation going through the same year level training program.
Table 12 – AMET Qualitative Data Results by academic year and rubric score (numerical figure represents the number of responses).

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<td></td>
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<td>75</td>
</tr>
<tr>
<td>3A Non-Constructive Criticism / Positive Experience</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3B Non-Constructive Criticism / Neutral Experience</td>
<td>1</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>3C Non-Constructive Criticism / Negative Experience</td>
<td>7</td>
<td>24</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DS3</td>
<td>DS6</td>
<td>DS9</td>
</tr>
<tr>
<td>1A Constructive Criticism / Positive Experience</td>
<td>4</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>1B Constructive Criticism / Neutral Experience</td>
<td>19</td>
<td>70</td>
<td>74</td>
</tr>
<tr>
<td>1C Constructive Criticism / Negative Experience</td>
<td>9</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>2A Neutral Criticism / Positive Experience</td>
<td>7</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>2B Neutral Criticism / Neutral Experience</td>
<td>52</td>
<td>73</td>
<td>64</td>
</tr>
<tr>
<td>2C Neutral Criticism / Negative Experience</td>
<td>25</td>
<td>98</td>
<td>70</td>
</tr>
<tr>
<td>3A Non-Constructive Criticism / Positive Experience</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3B Non-Constructive Criticism / Neutral Experience</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3C Non-Constructive Criticism / Negative Experience</td>
<td>5</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

The presentation of raw data in this fashion does not naturally lead to any conclusions, but it has been done for the sake of transparency. The primary focus of the qualitative data assessment is to try determine whether there has been a noticeable change in the critical nature of the feedback provided by the trainees or, whether there is an increase or decrease in the positive learning experience over time. The next series of tables are the result of analysing
the raw qualitative data to determine how the critical nature of the feedback has changed over the research period. Results are presented as a percentage of the trainee feedback per year level.

Table 13 – Percentage of constructive comments by Year level 2011-2013.

For each of the three year levels, Table 13 demonstrates a decrease in the percentage of constructive comments being provided by the trainees over the research period. These results are unexpected and they will have to be interpreted carefully, in relation to other results.
Table 14 – Percentage of non-constructive comments by year level 2011-2013.

Other than the 2012 period for 1st Year trainees, Table 14 demonstrates a reduction in the percentage of non-constructive comments being provided by the trainees over the research period, but the reduction is small and this result will have to be interpreted carefully in relation to other results.
Table 15 – Percentage of neutral criticism comments by year level 2011-2013.

Table 15 identifies an increase of neutral criticism comments for all three years across the research period. The change over time is not particularly significant being 10% or less however, this change was not foreseen.

The following series of tables are the result of analysing the raw qualitative data to determine how the trainee learning experience has changed over the research period. Results are presented as a percentage of the trainee feedback per year level.
Table 16 – Percentage of positive experience by year level 2011-2013.

Each year level has seen a continuous improvement of the percentage of trainee reporting a positive training experience throughout the research period. The most significant change occurred in 1st and 2nd Year, where both year levels experienced a 30% change from 2011 to 2013.
Table 17 – Percentage of negative experience by year level 2011-2013.

Each year level has seen a continuous decrease in the percentage of trainee reporting a negative training experience throughout the research period. The most significant change occurred in 1st Year where there was a 22% reduction in the reporting of negative training experiences from 2011 to 2013.
Table 18 – Percentage of neutral experience by year level 2011-2013.

The results presented in Table 18 remain largely consistent for the percentage of trainees reporting a neutral training experience throughout the research period, except 2nd years where there was a 19% reduction in the percentage of trainees reporting a neutral training experience.

**Statistical tests using aggregated data**

The following two tables use aggregated data from 2011 and 2013 to test the statistical significance of the changes in student satisfaction and student engagement, during the implementation period of the AMET program changes. As described earlier, there are two indicators of student satisfaction:

1. The proportion of participants reporting satisfaction with the AMET program in the quantitative surveys.
2. The proportion of qualitative comments about the AMET program categorised as positive.

There are also three indicators of student engagement:

3. The proportion of qualitative comments about the AMET program categorised as constructive.

4. The proportion of trainees who voluntarily participated in program evaluation by providing anonymous quantitative feedback.

5. The number of qualitative comments volunteered anonymously by participants.

The statistical significance of the changes, from 2011 to 2013, was tested using the two-tailed test for a difference in two proportions, with the z-statistic calculated as:

\[ z = \frac{p_{2013} - p_{2011}}{\sigma_{p_{2013} - p_{2011}}} \]

where

[\sigma_{p_{2013} - p_{2011}} = \sqrt{\frac{p(1-p)}{n_{2013}} + \frac{p(1-p)}{n_{2011}}}]

\( p_{\text{year}} \) is the proportion of satisfied/positive/constructive responses (or trainees voluntarily participating) in that year.

\( n_{\text{year}} \) is the total number of responses (or trainees) in that year, and

\( p \) is the pooled proportion of satisfied/positive/constructive responses (or trainees voluntarily participating) aggregated across both years.
Results of these statistical significance tests are reported in the table below:

<table>
<thead>
<tr>
<th></th>
<th>( n_{2011} )</th>
<th>( p_{2011} )</th>
<th>( n_{2013} )</th>
<th>( p_{2013} )</th>
<th>( z )</th>
<th>( p )</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proportion Satisfied</td>
<td>1036</td>
<td>53%</td>
<td>3064</td>
<td>79%</td>
<td>16.75</td>
<td>&lt; .0001</td>
<td>Highly significant</td>
</tr>
<tr>
<td>2. Proportion Positive</td>
<td>1121</td>
<td>10%</td>
<td>4452</td>
<td>36%</td>
<td>16.67</td>
<td>&lt; .001</td>
<td>Highly significant</td>
</tr>
<tr>
<td>3. Proportion Constructive</td>
<td>1121</td>
<td>33%</td>
<td>4452</td>
<td>27%</td>
<td>-</td>
<td>4.048</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>4. Proportion Participating</td>
<td>984</td>
<td>26%</td>
<td>984</td>
<td>78%</td>
<td>27.04</td>
<td>&lt; .001</td>
<td>Highly significant</td>
</tr>
</tbody>
</table>

**Table 19 – Results of Statistical Significance Tests**

Statistical significance testing is affected by sample size and the samples here are quite large, so there is a risk that even minimal changes will be classed as statistically-significant, despite the fact that they are of no practical consequence. Therefore, the effect size of each change was also estimated using Cohen’s \( h \), calculated as:

\[
h = \phi_{2013} - \phi_{2011}
\]

where

\[
\phi_{year} = 2 \arcsin(\sqrt{p_{year}})
\]

Effect sizes are reported in the table below:
Table 20 – Effect Sizes

<table>
<thead>
<tr>
<th></th>
<th>$n_{2011}$</th>
<th>$p_{2011}$</th>
<th>$n_{2013}$</th>
<th>$p_{2013}$</th>
<th>$h$</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proportion Satisfied</td>
<td>1036</td>
<td>53%</td>
<td>3064</td>
<td>79%</td>
<td>0.594</td>
<td>Medium Effect</td>
</tr>
<tr>
<td>2. Proportion Positive</td>
<td>1121</td>
<td>10%</td>
<td>4452</td>
<td>36%</td>
<td>0.578</td>
<td>Medium Effect</td>
</tr>
<tr>
<td>3. Proportion Constructive</td>
<td>1121</td>
<td>33%</td>
<td>4452</td>
<td>27%</td>
<td>-0.128</td>
<td>Minimal Effect</td>
</tr>
<tr>
<td>4. Proportion Participating</td>
<td>984</td>
<td>26%</td>
<td>984</td>
<td>78%</td>
<td>1.094</td>
<td>Large Effect</td>
</tr>
</tbody>
</table>

Table 21 – Number of Qualitative Comments Volunteered

Changes in the number of qualitative comments volunteered by participants from 2011 to 2013 cannot be tested statistically, but a simple graph demonstrates a four-fold increase:

Table 21 – Number of Qualitative Comments Volunteered

Both indicators of student satisfaction (1&2) increased significantly from 2011 to 2013, with a medium effect size of just below 0.6. Since these two indicators were measured in completely independent ways, the convergence between them is an indicator of their validity. Together, they provide strong evidence of a genuine improvement in student satisfaction.
Changes in the indicators of student engagement are somewhat more ambiguous. The proportion of constructive comments (3) has actually declined very slightly, but the size of this effect is minimal and it should be noted, that the proportion of non-constructive comments also declined. Both declined in favour of neutral comments. In contrast, the proportion of trainees voluntarily participating in program evaluation & improvement (4) has increased dramatically, as has the absolute number of qualitative comments volunteered by participants (5). These measures of voluntary contribution are, perhaps, better indicators of student engagement since increased engagement is the only plausible explanation available for such large increases in anonymous voluntary participation. They are also consistent with the change in student satisfaction and engagement and satisfaction should, in theory, be positively related.

So, the statistical analysis of changes in the aggregated data shows that student satisfaction did increase significantly and substantially during the implementation of the AMET program changes. Student engagement seems not to have been measured as reliably as student satisfaction, but the large increases in voluntary participation and the fourfold increase in voluntary contributions of qualitative feedback, in conjunction with the clear increase in student satisfaction, provide considerable evidence that student engagement has also increased during this period.

Summary of Chapter 6

The quantitative and qualitative data from ADFA’s biannual first year, second year and third year trainee review surveys has been analysed in this chapter and synthesised into numerical and tabular results. The raw quantitative and qualitative results have then been sequenced in
time by year level to facilitate time-series longitudinal analysis in the next chapter. The following Discussion Chapter will consider both the quantitative and qualitative data to measure the positive learning experience of trainees over time, and will analyse the qualitative data to measure the level of engagement demonstrated through provision of constructive criticism. The results of this analysis should provide an understanding of how the design and implementation of adolescent learning strategies has had an impact on the overall learning experience of trainees at ADFA during the period 2011-2013.
Chapter 6 – Appendix 1

Throughout the period 2011-2013 there were five different generations that experienced varying degrees of the new training programs as they were being implemented. These different generations are demonstrated in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Gen C</td>
<td>Gen B</td>
<td>Gen A</td>
</tr>
<tr>
<td>2012</td>
<td>Gen D</td>
<td>Gen C</td>
<td>Gen B</td>
</tr>
<tr>
<td>2013</td>
<td>Gen E</td>
<td>Gen D</td>
<td>Gen C</td>
</tr>
</tbody>
</table>

Table 4 - ADFA Generations during implementation of adolescent learning strategy 2011-2013

Where Table 10 represents the experiences of different trainee generations by year and military subject, Table 22 presents the experience of a particular generation by military subject moving through the training program and providing the opportunity to conduct a cohort analysis. This analysis requires the cohort to have experienced more than one year of training during the implementation period and accordingly is only applicable for generations B, C and D.

<table>
<thead>
<tr>
<th>Military Subject</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customs and Traditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen C</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen D</td>
<td>94</td>
<td>86</td>
<td>96</td>
</tr>
<tr>
<td>Drill and Ceremonial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen C</td>
<td>85</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>Gen D</td>
<td>91</td>
<td>89</td>
<td>89</td>
</tr>
<tr>
<td>Leadership Studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td>57</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Gen C</td>
<td>64</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Gen D</td>
<td>87</td>
<td>63</td>
<td>82</td>
</tr>
<tr>
<td>Equitiy and Diversity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td>87</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Gen C</td>
<td>86</td>
<td>91</td>
<td>87</td>
</tr>
<tr>
<td>Gen D</td>
<td>89</td>
<td>90</td>
<td>86</td>
</tr>
<tr>
<td>Healthy Lifestyle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen B</td>
<td>87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen C</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen D</td>
<td>84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 22 – AMET Quantitative Data Results by generation (numerical figure represents the percentage of students that recorded a positive response).

Most military subjects have seen an improvement of the percentage of trainees reporting a positive response for each generation throughout the research period. Gen B and Gen D Drill and Ceremonial, Gen D Equity and Diversity and Gen D Weapons Training are the only examples where the final result in 2013 returned a lower positive response percentage. However, even though these identified instances showed a decrease in positive response, the lowest result of these instances was still 74% positive. This alternate method of considering the data by cohort rather than year level has replicated the longitudinal results and confirmed that regardless of which way you interpret the data, the results remain consistent. As the only complete cohort, a targeted focus has been completed for ‘Generation C’ and the ‘highlighted’ subjects previously identified as having the most applicability to a constructivist learning model, and presented in table 23.
Table 23 – ‘Generation C’ cohort analysis of quantitative results for Leadership Studies and Military Communications
Chapter 7 – Discussion

Relatively recent neuroscientific research on the development and function of adolescent brains has provided additional support to the observations long made by psychologists; adolescents think, feel and process information, rewards and threats differently than do children or adults. The purpose of this research project was to consider whether the recent findings about young brains could be applied to develop adolescent learning strategies that would have a positive impact on the learning experience of midshipmen and officer cadets undertaking the Academy Military Education and Training (AMET) program at ADFA. Previously the Academy had experienced a series of high profile incidents of unacceptable behaviour that had resulted in multiple formal reviews that tended to focus on ‘Academy culture’ rather than the maturity of the trainees. Despite the adoption of an adult learning environment as recommended by several of the formal reviews (Grey, 1998 & Kafer, 2010), many of the behavioural problems persisted and the trainees continued to refer to low levels of motivation (Kafer, 2010). In 2011, ADFA began to implement a new approach to military education based on adolescent learning strategies. As these strategies were implemented, the staff conducted bi-annual internal trainee reviews with each year level and conducted open forum discussions with the trainees to discuss the results and make adjustments and improvements to the program. These internal trainee reviews asked trainees to respond, via Likert scales, to a series of closed-ended questions on each military subject before providing the opportunity to expand with additional details in an open-ended fashion. These reviews produced quantitative and qualitative data sets that were subjected to detailed time-series longitudinal analysis previously presented in the Chapter 6 - Results.
This Discussion Chapter will consider the results presented in the previous chapter in relation to the research question: Can an adolescent learning strategy improve the learning experience of 17-23 year old learners in an establishment such as ADFA?

The Methods Chapter proposed that the ‘learning experience’ would be operationalised as trainee engagement, trainee satisfaction, quality of instruction, and demonstrated achievement of the learning objectives; accordingly, the discussion will focus on analysing the results in the context of these elements of the learning experience.

Based on the experience of conducting this research, the discussion chapter will also make recommendations for how ADFA could make improvements to the ongoing measurement of the effectiveness of the adolescent learning strategy.

**Trainee engagement**

The Methods Chapter suggested that increased trainee engagement could be the result of greater trainee motivation and have a positive impact on the learning experience. Prior to any analysis of the contents of the quantitative or qualitative data, in establishing the suitability of the data for the conduct of the research, the Methods Chapter identified some indications of increased engagement. The response rate of trainees completing the online survey increased dramatically throughout the period implementation period of the adolescent learning strategy. The average response rate went from only 26% of trainees in 2011 to 77% of trainees in 2013. There are several possible explanations for the increased response rate. The first is that the staff may have increased or improved the systems of control and supervision to ensure that trainees were attending the mandated trainee review programs (extrinsic motivation), but this...
can only make them attend, not participate. Alternately, the introduction of open forum discussions conducted by the staff in response to each of the surveys may have produced greater engagement with the trainees in the conduct of the evaluation process (intrinsic motivation). Also, it is possible the trainees may have started to see some of their feedback influencing the AMET program, and this may have improved their sense of value and efficacy in the process. Finally, it may have been greater satisfaction in the AMET program due to the holistic application of adolescent learning strategies. Although there is no way to know which combination of these explanations resulted in the increased response rate, each explanation can be related to proposed adolescent learning factors. Whether it was increased supervision and mentorship through the staff engagement in open forums, or greater engagement and satisfaction in the AMET program due to adolescent learning strategies, each explanation has roots in the theories proposed in this study.

In addition to the increased response rate, the methods chapter also identified a significant increase in the volume of answers being provided to the open-ended questions in the on-line survey. The surveys conducted in 2011 and the surveys conducted in 2013 had an average of 21 pages of questions however, 2011 produced an average of 20 pages of qualitative response, 2013 produced an average of 86 pages of qualitative responses. So, for the same number of questions, the volume of responses increased more than four times. While it is possible that increased staff supervision may have improved trainees’ attendance at trainee reviews, it is very unlikely to have affected trainees’ responses, which were anonymous and confidential. This is particularly true of their written responses to open-ended questions which were entirely voluntary. The additional quantity of written responses appears to indicate increased trainee engagement and suggests that the motivation is intrinsic, and not just the result of
staff influence increasing response rates through supervised attendance at programed trainee review periods.

**Quantitative data.** The analysis of the quantitative data was done in a manner intended to produce an indication of overall trainee satisfaction by particular military training subject, so there are no inferences that can be drawn from the quantitative data that relate to trainee engagement, apart from the response rate discussed above.

**Qualitative data.** The scoring rubric was designed to determine whether written responses to open-ended questions were reflective of constructive or non-constructive feedback, and a positive or negative training experience. It was expected that constructive feedback would increase relative to non-constructive feedback, and that this would be reflective of increased trainee engagement. It must be remembered that unlike the compulsory quantitative questions, the qualitative responses were voluntary, and that there is no way to determine from the data what percentage of the surveyed population chose to provide a qualitative answer. The results of the qualitative data analysis for constructive comments are presented in the table below:
Table 13– Percentage of constructive comments by Year level 2011-2013.

These results, viewed alone, seem inconsistent with an increase in engagement. By themselves these results are difficult to explain however, when considered in conjunction with the next table, showing the percentage of non-constructive comments, an explanation becomes more evident.

Table 14– Percentage of non-constructive comments by Year level 2011-2013.
The decrease of non-constructive comments is consistent with an increase in engagement. When considering both tables together it is possible to suggest that the results may actually be demonstrating an indication of trainee satisfaction rather than trainee engagement. It is possible that the steady state of constructive comments and the decrease of non-constructive comments is reflective of an overall increase in trainee satisfaction with an improved AMET program. Improvements to the AMET program may suggest that there is less to be critical of, and although constructive comments have remained the same, the non-constructive comments have not decreased as a result of increased trainee engagement, but rather as a result of improvements in the training program. It is also possible that relative steady state of constructive comments throughout three years (2011-2013), and three year levels (Year 1, 2 & 3), with only a 15% divergence amongst 1st Year results, has merely identified the normative percentage of the population who provide constructive feedback. These results would need to be compared against alternate research in order to validate this explanation.

It could be argued pedantically that constructive feedback did increase relative to non-constructive feedback, but this was really due to the reduction in non-constructive feedback in favour of neutral feedback. There was no increase in the proportion of constructive feedback. It appears that despite the planned intention for the scoring rubric to measure the level of engagement from the constructive feedback in the qualitative data, after analysis, these particular results cannot confidently be interpreted to have produced any conclusions in relation to engagement.

The statistical tests, reported in Chapter 6, reveal only minimal changes to the proportion of constructive comments. In contrast, the positive effect on the voluntary participation rate (survey response rate) was both statistically significant and large, increasing from 26% to 78%.
Although the increase in number of voluntary qualitative contributions could not be tested statistically, a simple graph (Table 21) showed a fourfold increase in this measure.

It appears that the better measure of trainee engagement were the voluntary participation rate in the quantitative surveys and the number of voluntary contributions in the form of qualitative feedback. Whether these indicate greater engagement in the program evaluation process or greater engagement in the AMET program itself is unclear, but they do seem to indicate an improvement in the engagement of trainees at ADFA during the period when adolescent learning strategies were implemented.

**Trainee satisfaction**

The Methods Chapter explained that the quantitative answers to close-ended questions would be coalesced to provide an average ‘satisfaction’ result for each military subject that could be measured over time. In relation to the qualitative results the Methods Chapter presented a scoring rubric that in addition to measuring engagement, would also consider whether the comment referenced a positive or negative experience as an additional measurement of trainee satisfaction. This section will review the results of the time-series longitudinal analysis of quantitative and qualitative data to determine whether trainee satisfaction as an element of the overall learning experience was positively impacted by the adolescent learning strategy. This section will also highlight the results for those military subjects with higher cognitive requirements: leadership and military communications, to determine whether the increase in satisfaction will have had a more significant result (as predicted in Chapter 4) than subjects that are less cognitive such as Drill and Physical Training.
**Quantitative data.** As previously explained, the internal training reviews were conducted with the SurveyMonkey® on-line tool. The quantitative data results were mapped in a *Likert Scale* after trainees were asked to select ‘Strongly Agree’, ‘Agree’ ‘Disagree’ ‘Strongly Disagree’ ‘Don’t Know’ to a series of closed-ended questions. The results from these reviews were presented as a percentage score amalgamating the number of trainees that selected ‘Strongly Agree’ or ‘Agree’ as a measure of positive experience for a particular military subject that could be examined over time. The results from the analysis of quantitative data to determine the percentage of trainees that had a positive training experience as a measure of trainee satisfaction are presented in the following table:

<table>
<thead>
<tr>
<th></th>
<th>1st Year Students</th>
<th>2nd Year Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customs and Traditions</td>
<td>94</td>
<td>86</td>
</tr>
<tr>
<td>Drill and Ceremonial</td>
<td>91</td>
<td>89</td>
</tr>
<tr>
<td>Leadership Studies</td>
<td>64</td>
<td>57</td>
</tr>
<tr>
<td>Equity and Diversity</td>
<td>89</td>
<td>90</td>
</tr>
<tr>
<td>Healthy Lifestyle</td>
<td>84</td>
<td>76</td>
</tr>
<tr>
<td>Military Communications</td>
<td>55</td>
<td>41</td>
</tr>
<tr>
<td>Military Law</td>
<td>76</td>
<td>79</td>
</tr>
<tr>
<td>Physical Training</td>
<td>93</td>
<td>96</td>
</tr>
<tr>
<td>Weapons Training</td>
<td>93</td>
<td>86</td>
</tr>
</tbody>
</table>
### Table 10 – AMET Quantitative Data Results by academic year and military subject (numerical figure represents the percentage of students that recorded a positive response / Yellow highlighted boxes reflect the subjects with higher cognitive requirements).

The results presented in Table 10 are entirely consistent with a positive impact on the learning experience through increased trainee satisfaction. Most military subjects in all three year levels have seen an improvement of the percentage of trainees reporting a positive response throughout the research period. 1\(^{st}\) Year *Customs and Traditions, Equity and Diversity,* and *Weapons Training,* and 2\(^{nd}\) Year *Drill and Ceremonial,* and *Weapons Training* are the only instances where the final result in 2013 was lower than the percentage recorded in 2011. However, even though these identified instances showed a decrease in positive response, the lowest result of these instances was still 74% positive.

The statistical test conducted with aggregated data at the end of Chapter 6 demonstrated that the proportion of respondents indicating satisfaction with AMET courses increased significantly from 2011 to 2013, with a medium effect size. The cause of this effect cannot be proven...
categorically, but the major change to the program in this period was the introduction of adolescent learning strategies.

As originally proposed in Chapter 4, the subjects with the greatest cognitive requirements, leadership and military communications, have seen the most dramatic improvement of trainee satisfaction throughout the research period.

Table 11 – Quantitative results for Leadership Studies and Military Communications.

Table 11 shows that if the two scores for a subject within each year are averaged, and the results from 2011 and 2013 are compared, it can be seen that trainee satisfaction results for Leadership improved by: 28.5% in 1st Year, 25.5% in 2nd Year and 21% in 3rd year. Trainee satisfaction results for Military Communications improved by: 22.5% in 1st Year, 31% in 2nd Year and 30.5% in 3rd Year. It is not possible to prove that the application of an adolescent learning strategy is exclusively responsible for the improvements in trainee satisfaction because there
are too many other changing variables that may have influenced these results. For example, detailed analysis of the individual comments in the qualitative data provides evidence to suggest that changing a single instructor or subject Package Master can dramatically influence trainee satisfaction results. It is possible that the improvements in Leadership and Military Communications could merely be the result of high quality staff with efforts focused on subjects that had historically returned low trainee satisfaction results. However, these alternative explanations could be applied to all of the subjects listed above. It is therefore, telling that the two subjects demonstrating the greatest increases in trainee satisfaction are those cognitively-demanding subjects to which the research question is most relevant: Leadership and Military Communications. The substantial effects on these cognitively-demanding subjects, alongside the very modest effects, if any, on the less cognitive subjects, are exactly what constructivist learning theories, informed by adolescent brain research, would now predict from the implementation of adolescent learning strategies.

Interestingly, during the implementation period for adolescent learning strategies, the pass mark for all Academy Military Education and Training subjects was increased from 50% to 80% to align ADFA with the training standards of the single service officer training establishments HMAS Creswell, RMC Duntroon and Officer Training School East Sale. Despite the increased pass mark during the implementation period, the trainee satisfaction level for most subjects remained steady, and in the case of Leadership and Military Communications, trainee satisfaction improved significantly. It may be that the increased pass mark requirements also influenced the trainees association of value with the subject and subsequent sense of achievement and satisfaction levels.
Qualitative data. In addition to measure whether written responses were reflective of constructive or non-constructive feedback, the scoring rubric developed in the Methods Chapter was also intended to identify positive or negative training experiences from the answers provided to the open-ended questions. It was expected that the application of adolescent learning strategies would see an increase in the number of trainees reporting a positive training experience, and a decrease in the number of trainees reporting negative training experiences. As with the analysis of qualitative data for trainee engagement, it must be remembered that unlike the compulsory quantitative questions, the qualitative responses were voluntary, and there is no way to determine from the data what percentage of the surveyed population chose to provide a qualitative answer. The results of the qualitative data analysis for positive training experiences are presented in the table below:

Table 16 – Percentage of positive training experience by year level 2011-2013.

The results presented in Table 16 are entirely consistent with a positive impact on the learning experience and suggest that an increase of reported positive training experiences would be an indication of greater trainee satisfaction. Each year level has seen a continuous improvement
of the percentage of trainee reporting a positive training experience throughout the research period. The approximately linear improvement, year-by-year, from 2011 to 2013 matches that seen in the quantitative data and supports the proposition that improvements in the quantitative data were not mere due to the questionnaire’s redesign.

The statistical test conducted in Chapter 6, show a medium-sized positive effect on the proportion of qualitative comments reflecting a positive learning experience and the increase was statistically significant.

Similar to the analysis of the quantitative data for trainee satisfaction, there are too many other variables to suggest that the application of adolescent learning strategies is individually responsible for the increase in positive training experiences. For example, Recommendation 12 of the Broderick Review contained a series of sub-recommendations focused on improving the processes for the selection and sustainment of high quality staff at ADFA. This recommendation was applied during the same period as the implementation of adolescent learning strategies during 2011-2013, and it is possible that the increased trainee satisfaction could merely be attributable to higher quality instructional staff. However, all ADFA staff were required to participate in education on adolescent learning strategies, each staff member had two of their instructional lessons per year evaluated, and all staff receive bi-annual feedback on the result of the internal training review process. Accordingly, it is probably more likely that it was the combination of high quality staff actually applying the adolescent learning strategies that was responsible for the increased rate of reported positive training experience.
The results of the qualitative data analysis for negative training experiences are presented in the table below:

Table 17 – Percentage of negative training experience by year level 2011-2013.

The results presented in Table 17 are entirely consistent with a positive impact on the learning experience and suggest that a decrease of reported negative training experiences would be an indication of greater trainee satisfaction. Each year level has seen a continuous decrease in the percentage of trainee reporting a negative training experience throughout the research period. As with the analysis of the qualitative data for positive training experience, there are far too many variables to suggest that the application of adolescent learning strategies is individually responsible for the decrease in negative training experiences. This result is encouraging, nevertheless.
Quality of Instruction

The Methods Chapter proposed that the ‘quality of instruction’ would be one of the factors that influenced the ‘learning experience’ being measured by this research however, the ADFA internal training reviews yielded insufficient data to do this. Measuring changes in the ‘quality of instruction’ would have required the prior development of a suitable questionnaire in 2011. Unfortunately the opportunity to do so had passed by the time this research commenced. It may be reasonable to assume that a positive, neutral or negative training experience could in some way be attributable to the quality of instruction. Accordingly, although the development of a specific measurement for ‘quality of instruction’ ended up being beyond the scope and capacity of this research, it is considered that the increase of positive responses in the quantitative data, and the increase of positive comments and decrease of negative comments in the qualitative data, might be considered prima facie evidence of improved ‘quality of instruction’ but this must remain a matter for conjecture. Development of a questionnaire to measure quality of instruction in the AMET program remains a priority for future research.

Demonstrated Achievement of the Learning Objectives

The Methods Chapter suggested that ‘demonstrated achievement of the learning objective’ would be another aspect of the ‘learning experience’. It also identified that the learning objectives were more expansive than academic and military assessment results and also included values, attitudes and discipline statistics and that in addition to the classroom, the assessable environments included residential, social and sporting venues. The quantitative and qualitative data from the internal trainee review process did not include any information in relation to demonstrated achievement of the learning objectives and accordingly, analysis of academic and military results and discipline statistics is outside of the scope of this research
Implementation of the changes in 2011-2013 included raising the pass mark in AMET subjects from 50% to 80%. Perhaps surprisingly, this did not result in any long-term drop in the pass rate amongst trainees. This might be considered prima facie evidence of improved achievement of the learning objectives, but this too, must remain a matter for conjecture and a priority for future research.

Summary of Chapter 7

The purpose of this research project was to consider whether the tailor made adolescent learning strategies based on research into brain development and educational psychology implemented by ADFA would have a positive impact on the learning experience of midshipmen and officer cadets undertaking the Academy Military Education and Training program at ADFA. The learning experience was considered to be a combination of trainee engagement, trainee satisfaction, quality of instruction, and demonstrated achievement of the learning objectives. Conducting time-series research through a secondary longitudinal analysis of the existing statistics on ADFA’s internal trainee review, has enabled this project to consider the generic effect of an adolescent learning strategy on ADFA trainees throughout the implementation period of 2011-2013. Much like the neuroscience they are based on, it is impossible to scientifically ‘prove’ that any adolescent learning strategy has directly had a positive impact on the learning experience. Quite simply, there are too many variables to consider. There is no doubt that ADFA considerably changed the manner with which it engaged with it 17-23 year old trainees during the 2011-2013 period. This change, intentionally shifted away from
previous formal reviews that recommended the application of an adult learning environment. Instead, ADFA implemented strategies intended to harness the strengths of developing adolescent brains, whilst recognising the limitations and emphasising supervision and mentorship to try and protect the trainees from a biological immaturity that was beyond their own control.

This research has identified evidence to suggest that the learning experience of midshipmen and officer cadets has been positively impacted through the period that ADFA was implementing adolescent learning strategies. The quantitative and qualitative data suggests that trainee engagement has improved, they reported higher training satisfaction levels and less negative training experiences. Although it is possible that these changes are merely the result of increased staff and trainee effort post the high profile 2011 Skype incident and subsequent Broderick Review; they are precisely what would have been expected from the implementation of an adolescent learning strategy. The fact that the greatest improvements were measured in the more cognitively demanding courses, just as the adolescent brain research would have predicted, suggests that something more than increased effort is behind these effects.

ADFA has had many formal reviews in the past and implemented many previous recommendations. Although some of the previous reviews reduced levels of unacceptable behaviour, prior to the implementation of adolescent learning strategies in 2011, none of the previous reviews had any noticeable impact on reports of low motivation. Accordingly, it is likely that the application of adolescent learning strategies through the 2011-2013 period has been in part responsible for the statistically significant improvement in the trainee learning experience discussed through this research.
Limitations on this study

All research studies have limitations. The main limitations of this study relate to its generalisability, research design, measurement and scope:

Generalisability. Generalisability of the results of an empirical study is always limited by its sampling frame and the sampling method used to select participants. Under ideal conditions, a study's sampling frame would be the whole population to which the study might be generalised (e.g., all of the world's 17-25 year olds) and the sampling method would be true random sampling. Of course, such ideal conditions are rarely, if ever, encountered in social, educational or organisational research. Generalisability is, therefore, always limited and those limits should be articulated to reduce the likelihood of inappropriate overgeneralisation. On the other hand, there are also cases which are sufficiently important to warrant research without any expectation of generalisability beyond the case. ADFA is a national institution with a distinctive and very important role: educating future officers of the Australian Defence Force to improve their learning, decision making and leadership capabilities. The generalisability of the neuroscientific and educational research that this study draws upon is a matter of ongoing scholarly debate, but the specific changes at ADFA which are the focus of this study need not be generalisable to be valuable. Improving the learning experience at ADFA improves the organisation's ability to achieve its mission and this is sufficiently important to Australia to warrant research without expectation of generalisability beyond ADFA.

Even so, cautious application of these results might be reasonable in any context of which this study can be regarded as representative; for example, other institutions with similar missions,
cultural characteristics and age demographics, such as military academies, police academies or emergency services academies in Anglophone nations. This is, of course, a matter for judgement and any attempt to replicate the changes implemented at ADFA should be evaluated using appropriate research methods.

**Research design.** The preferred way to evaluate the effects of an organisational or educational change is to use a quasi-experimental design, with an intervention group experiencing the change and a comparison group continuing with the status quo, at least initially, so that systematic differences can be observed. Random assignment of participants to these two groups ensures that the only systematic difference between groups is the intervention itself. Quasi-experimental design allows any significant differences between the experiences of the groups to be attributed to the change or intervention. Of course, a quasi-experimental research design requires very substantial control by the researcher. In many cases of organisational change, there are other powerful stakeholders and other important agendas beyond the researcher's control, so a quasi-experimental design is rarely feasible 'in the wild'. In this case, there was also a time lag between the decision to implement changes and the decision to evaluate those changes formally, in a research study. By the time the latter decision was made, any opportunity for designing the study in anticipation of changes had passed.

As such, this study cannot demonstrate causation. It can demonstrate an association, though, and the implementation of the changes at ADFA do appear to have been associated with significant and substantial improvements in student engagement and student satisfaction. The changes were inspired by research on adolescent brain development, but attributing the success of those changes to their effect on the adolescent brain is, unfortunately, beyond the
capacity of this *post hoc* research design. Other possible causes have been suggested and causal attribution is another matter for the reader's judgement.

**Measurement.** The *post hoc* nature of the research design also precluded the selection, or development and testing, of measurement instruments best suited to the task. The investigation required an opportunistic approach and, fortunately, considerable data had been collected through the internal training review process. If the evaluation research had been designed alongside the program changes, well-established instruments would have been selected to measure student satisfaction and student engagement during the 3-year implementation process, along with other variables of interest, such as instructor quality and student achievement. When possible, it is preferable to select instruments whose reliability and validity have been tested because use of such instruments increases the confidence in, and credibility of, the data collected.

In this study, that preferred approach was not possible. However, data from the internal training reviews were selected to serve as indicators of student satisfaction and student engagement. This opportunistic selection of available indicators was balanced by the use of multiple, independently-measured indicators of each variable: two for satisfaction and three for engagement. The convergence of the two indicators of satisfaction, along with their face validity, is an encouraging sign that they are indeed measuring student satisfaction. Likewise, two of the three indicators of engagement converged and those two were based on behavioural measures (voluntary participation and voluntary contribution of qualitative feedback) rather than self-reports. Well-established instruments would have yielded more credible data and the results generated from the opportunistically-selected indicators should
be interpreted with some caution. Nevertheless, they do provide *prima facie* evidence of positive effects and they are definitely sufficient to warrant further research on this topic.

**Scope.** The conduct of the military training program only accounts for approximately 20% of the trainee’s time at ADFA with the remainder of their time being spent in tertiary studies, voluntary extracurricular activities, sport and recreation. A broader analysis of the impact of the adolescent learning strategy might have included these other environments and also considered longitudinal analysis of other data such as discipline statistics, military academic and tertiary results. Unfortunately, due to the commencement of this research after the 2011-2013 implementation period, the opportunity to frame the project to consider these additional parameters was not possible.

There is no way to conclusively prove from the available data that the implementation of an adolescent learning strategy had a positive impact on the learning experience, but analysis of the data has demonstrated a statistically significant improvement in satisfaction and engagement throughout the implementation period.

**Recommendations for future analysis**

Through the conduct of this research project there have been lessons learnt, that with the benefit of hindsight, would have modified the conduct of the research, the parameters of the application for ethical approval and produced a more comprehensive answer to the research question. There have also been knowledge discoveries that may be useful for the continuous improvement of ADFA’s adolescent learning strategies.
The internal trainee reviews are an excellent tool for assessing the experience of midshipmen and officer cadets in the conduct of Academy Military Education and Training however, they only account for approximately 20% of the trainee’s time at ADFA. The remainder of the trainee’s time is spent in tertiary study with University of NSW staff, playing sport, participating in recreational or social activity, or in their private accommodation. To gain a comprehensive understanding of the implications of an adolescent learning strategy, ADFA should consider tools that measures every aspect of the trainee’s experience: tertiary academic, military, sport, social and residential. Some of these tools may already exist (such as unacceptable behaviour surveys and discipline statistics) and some may require modification, but they should all be reviewed to reduce any duplication and ensure the trainee experience is being captured and measured in its entirety.

On several occasions this research paper has stressed the importance of motivation as the fuel or foundation for constructivist learning. For this reason the paper has continuously returned to the Interactive effects of Environment, Expectation, and Value on Motivation table produced by Ambrose, Bridges, Lovett, Di Pietro and Norman (Table 1) in order to understand the circumstances and environments that produce motivated learners. However, when analysing the questions used in ADFA’s internal trainee review, it became apparent that they don’t appear to be focussed on the elements of motivation identified by Ambrose, Bridges, Lovett, Di Pietro and Norman. It is suggested that the inclusion of a series of questions based around motivation may give the ADFA staff a better indication of the trainee learning experience; where it may be deficient from the perspective of the trainees; and therefore, better target the continuous improvement process. The following suggested questions have
been developed in consideration of Neuman’s 10 frequent errors identified in the Methods
Chapter (Neuman, 2000):

1. I consider the relevance of this subject for my future career as an officer to be: of no
importance / of some importance / of critical importance.

2. I consider the relevance of this subject for my life at ADFA to be: of no importance / of
some importance / of critical importance.

3. During this subject my instructor demonstrated: no support for my learning / support
for my learning when I needed it / strongly encouraged my learning.

4. During this subject my fellow classmates: distracted my learning / had no impact on
my learning / encouraged my learning.

5. My expectation of being able to achieve the required standard for this subject was:
low / reasonable / high.

In addition to the Academy Military Education and Training program, the above style of
questioning could also be given to the trainees to measure their motivation in other ADFA
environments such as sport, social, and residential settings. For example:

1. My sport Supervising Officer is: not interested in my development / approachable / a
good mentor who is interested in my development.

2. During formal social activities the ADFA Staff: are unprofessional / are present but
disengaged / are good role models for acceptable behaviour.

3. I would describe my ADFA Classmates impact on my social life as being: disrespectful
or isolating / comfortable amongst my close friends / generally inclusive and
encouraging.

4. When raising issues with my Divisional or other ADFA staff I am: worried about the
administrative consequences for myself and the others involved / happy that staff are
approachable if I need them / confident that myself and the others involved will be supported.

5. The ADFA Values are: impossible to apply all the time / aspirational, but hard to live up to all the time / exactly what I expected from military service, and easy to live in my day to day life.

These example questions are aimed at understanding how the trainees feel about the supportive nature of their environment, the value they attribute to the activity and their expectation of achieving the expected outcome. The questions are phrased around how the trainees feel themselves to get a sense of their personal perception rather than asking them to make a subjective assessment. For example, trainees are not qualified to conduct a training needs analysis and lack the experience to know what should be included in a curriculum however, asking them to consider the relevance of a subject will provide ADFA staff with an indication of whether or not the trainees value the lesson and may identify that more work is required to define the reason for learning and importance for their careers. Using questions of this nature should give ADFA staff a clearer understanding of student motivation levels. The motivation of students to learn is probably the best measure of a successful learning strategy.

Although this research has identified a statistically significant improvement in the learning experience of trainees at ADFA based on a secondary analysis of existing data, ADFA could use the lessons learnt during this research project to produce a much more refined and targeted measurement of trainee motivation and the utility of an adolescent learning strategy across all aspects and environments involved in the learning experience.
Chapter 8 – Conclusion

In 2011 ADFA was again the focus of public scrutiny by media reports in relation to the so-called Skype incident. For many, this incident was seen to be the continuation of unacceptable behaviour that had previously been identified and thought to have been addressed by cultural reforms resulting from the 1998 Grey review. As a result, a series of formal reviews into ADFA and the wider ADF were commissioned by the Defence Minister.

Aside from, and prior to the Skype incident, ADFA had already begun to review internal processes and procedures. In 2009, the Commandant of the Australian Defence College commissioned the Commandant of ADFA to complete a review to audit the implementation of post Grey Review reforms. The Kafer Review that was subsequently submitted in 2010 found that although there was no evidence to suggest that the extreme cultural deficiencies of the Grey Review had returned, there was evidence of intolerance, aggression and negative social behaviour. The report also noted that the trainees reported low levels of motivation and that the incidence of trainees lying to staff was high. In consideration of the findings of the Kafer Review, and intensified as a result of the Skype incident, ADFA began to research whether the adult learning environment advocated by the Grey and Kafer Reviews was the most suitable approach for the 17-23 year old midshipmen and officer cadets undertaking training.

This research commenced with the detailed review of contemporary literature on brain based learning, cognitive neuroscience and educational psychology. Of particular importance, this review identified significant relatively recent research that suggested that the maturation and development of the brain of 15-25 year olds inferred very different behaviours than that of children or adults outside the identified age range. This research suggested that although
adolescents were cognitively just as capable as adults, under certain circumstances, such as the presence of their peers or heightened emotions, their higher level executive decision making could be compromised by the different manner with which they processed threats and rewards. The review also suggested that in comparison with adults, adolescents have a very different sense of value, preferring short term extrinsic rewards and peer status, unlike adults who tended to place more value on intrinsic rewards. These findings seemed to suggest that despite their age and the high degree of responsibility expected of them as commissioned officers upon graduation, the 17-23 year old trainees at ADFA were not well suited to the adult learning environment proposed by the Grey and Kafer Reviews.

In the absence of any identified adolescent learning strategy, this research used the information from the literature review to develop a number of factors that formed the foundation of an adolescent learning strategy to be applied at ADFA. These strategies harnessed the strength of the reward driven adolescent brain, whilst recognising the limitations of expected performance in environments of heightened emotion and peer interaction. The strategies focused on supervision and guidance to achieve results through mentorship and prevention rather than consequence based punishment after the event.

An internal training review process was used to track the results of the adolescent learning strategy as it was implemented through the 2011-2013 period. These internal training reviews facilitated the conduct of time-series research through a longitudinal analysis of the existing data. Although with the benefit of hindsight some of the questions would have been changed and parameters of the research would have been broadened to include discipline statistics, tertiary, sporting, residential and social environments, the analysis conducted has still identified statistically significant improvements in trainee motivation and satisfaction.
Although it is impossible to prove that the improvements in trainee motivation and satisfaction were caused by ADFA’s adolescent learning strategies, there is a certainly a strong association between the implementation of adolescent learning strategies and those observed improvements.

‘When we treated them like adults, they used the freedoms associated with an adult learning environment to behave like children. When we reduced their freedoms as a result, the trainees said ‘you are treating us like kids’. When we started treating them like adolescents, their behaviour improved and they gained additional freedoms. ‘Finally’ they said ‘you are treating us like adults’.

Chief Instructor ADFA, 2013.
References


