LEARNING CHESS AND THE DEVELOPMENT OF COGNITIVE THINKING IN QUEENSLAND PRIMARY SCHOOLS: AN EXPLORATORY STUDY

A Thesis submitted by

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Abstract

Prior to the main study, to help decide the research question, the researcher conducted a survey of 315 stakeholders from the 'chess in schools' community of South East Queensland and Northern NSW. This group, which included 52 school principals, 52 school teacher chess coordinators and 109 parents of children currently learning chess, voluntarily answered a 34-question, quantitative online survey in 2016. More than 300 agreed or strongly agreed that learning chess helped children with a range of thinking skills. Each question gave respondents the opportunity to make comments. The 841 comments provided a wealth of information on a whole range of aspects regarding chess in schools.

The main study conducted during the 2017 school year at Somerset College, Gold Coast, Queensland, Australia, built upon the study by Martinez (2012) by examining whether a range of chess related and non-chess related variables affected the cognitive thinking scores of the chess group as compared to the control groups. Several previous studies in the field of chess and cognitive thinking skills of children have shown a small improvement for the chess group, but others have shown no such improvement.

Two hundred and three students and their parents opted into the main study and they formed four groups: chess, music, both and neither. Eighty-three students receiving weekly chess lessons during class time at school, formed the chess group and answered a verbal survey of 22 questions on a range of variables, including what extra chess learning and playing they had done. Other variables included confounding factors such as whether they had private non-chess tuition or regularly visited a tuition company. The descriptive analysis indicated small improvements in cognitive thinking scores for the chess and music groups, but these did not correlate at a statistically valid level. Variables involving extra chess participation showed small improvements, but findings were hampered by having a relatively small sample group for the students playing and learning the most extra chess. Based on these findings, the researcher provides some ideas for the progression of research, including the need for a longitudinal study following students at an individual level.

Certification of Thesis

This thesis is entirely the work of Graeme C Gardiner except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Principal Supervisor: Dr Luke van der Laan

Associate Supervisor: Dr Neil Martin

Student and supervisors' signatures of endorsement are held at the University.

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Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
ACER	Australian Council for Educational Research
AGAT	ACER General Ability Test
ANOVA	Analysis of Variance
ASD	Autism Spectrum Disorder
CCSCSL	Chess Club and Scholastic Center of St Louis
EEF	Education Endowment Fund
FIDE	Federation Internationale des Echecs (International Chess Federation)
MANOVA	Multivariate Analysis of Variance
ODD	Oppositional Deficit Disorder
QJRL	Queensland Junior Ratings List
RPM	Ravens Progressive Matrices
SPT	School Performance Test

Chapter 1 – Introduction

The researcher, with nearly 30 years of experience in the field of chess and education, is inspired to conduct this work.

In this dissertation the world of ‘chess in education’ is examined, particularly the thinking skills often linked with learning to play chess. Educators and parents are often told that there are benefits for their children in learning to play chess, but is this true? Is it backed by scientific evidence? In Australia and several other countries, for example China, India, USA, UK, South Africa and New Zealand, there is a growing number of professional ‘chess in schools’ coaching companies, that like to be able to quote scientific research for the benefit of stakeholders.

In early 2016 the researcher conducted a survey of stakeholders that included 52 school principals, 52 teacher chess coordinators, 109 parents of children who were learning to play chess, teachers and chess coaches. The results of the survey made it clear that most of the 315 respondents believe that learning chess helps children with an array of thinking skills. A review of the literature revealed that research into the benefit of learning chess concerning improvements in cognitive thinking skills for students aged 5-11 is a key area of interest for stakeholders. There have been several studies over the years that have shown modest improvements in test scores for chess players against control groups, whilst others have shown no such improvement.

The researchers in a recent study (Jerrim et al, 2017) involving more than 4,000 children in the UK found no improvements in this area. They were critical of previous research in the field and concluded that ‘a number of studies suggest that teaching children how to play chess may have an impact upon their educational attainment. Yet the strength of this evidence is undermined by limitations with research design.’

The researcher of this study has been motivated by Martinez (2012) who conducted a study with four groups, chess, music, both and neither. In particular he attempted to measure how much extra chess each student had each week. On the basis that

children need practice to retain the ideas learned, the researcher decided to conduct a similar study to that of Martinez to measure how much extra chess each child had played, and thus add more detail to the work of Martinez.

During the 2017 school year, the researcher conducted a study at a school in South East Queensland which has enjoyed outstanding achievements in chess for the past 25 years. There was a reasonable chess cohort to study (83 opted-in) of a total cohort of 203 (which also opted-in). The four groups comprised chess (46), music (48), both (37) and neither (72). There were 117 males and 86 females involved. There were 38 students from grade 1, 35 from grade 2, 34 from grade 3, 56 from grade 4 and 40 from grade 5. Before and after test scores for cognitive thinking skills for the 2017 school year were provided by the school, along with basic data such as gender and year level. Immediately after the 'after' tests were conducted, the 83 chess students undertook a verbally administered survey, which included 22 multiple choice questions.

These survey questions were related to whether each student attended lunchtime club, whether they played chess at home, whether they receive regular private chess lessons at home and whether they were a member of an outside school chess club. Other questions looked at motivation, regularity, teacher effect, parent effect and confounding factors. The researcher also obtained publicly available Queensland Junior Chess Ratings where applicable. In addition, students were given the opportunity to provide 'open-ended' comments, which are included in this study.

The results of the statistical analysis of the initial survey are given in Chapter 4, and of the main study in Chapter 5 of this dissertation.

Finally, the findings of the research are discussed, and theories considered along with suggestions for future research in the field.

Chapter 2 - Literature Review – Chess and Education

2.1 A Brief History of Chess and its Status in the World

The game of chess has a rich culture and heritage from at least the sixth century AD. Much of the early history occurred through communications along the Silk Road. To this day, countries along the Silk Road tend to dominate the world of chess. China, India, and Russia, which together make up nearly half the population of the world, along with countries like Armenia, Azerbaijan and other nations in Central Asia, lead the world of competitive chess. An exception to this was at the 2016 Chess Olympiad when the USA were the champions. However, this researcher, when attending the World Chess Congress in Istanbul in 2000, found that, in chess terms, western nations can be considered 'third-world'.

There have been several books devoted to the history of chess, but, although written over 100 years ago, *A History of Chess* (Murray, 1913) is still recognised by many as the most carefully researched. Murray argues (44-47) that chess probably evolved from an Indian board game around the sixth century AD, and that 'chess was certainly in existence in the seventh century AD, and it had already at that time penetrated to Persia'. At that time the Middle Persian *Chatrang-Namack* praised chess because it depended upon intellect alone.

Murray names several chess books (with authors) dated in the 9th and 10th centuries, including *Book of the Chess*, *Elegance in Chess* and *Book of Chess-Positions or Problems.* He describes algebraic chess notation which was introduced in 1173 (Murray, 495) and notes various rule changes in the 13th, 14th and 15th centuries.

Paul Morphy became the first (unofficial) world champion in 1859, and the first New Zealand Chess Championship (the world's longest running national chess championship) was held in 1879. In modern times, names like Bobby Fischer, Anatoly Karpov, and Gary Kasparov are of world renown. In November 2016

Magnus Carlsen of Norway defeated Russian Sergey Karjakin to retain the title of world chess champion.

Chess history includes countless fascinating stories going back many centuries. The world champions each have their stories, and the large body of opening theory along with the names and origins of each opening, along with major variations, provide a fascination for students as they progress through the ranks.

Chess is a game enjoyed by many millions of people throughout the world. It is a pure game, with no element of luck. Every single move presents a new problem to solve and after the first few moves, in most cases, the player will never have seen the position previously. Every move is a test of the thinking skills of the player. It is a game which, generally, is inexpensive to play.

The number of member nations of the IOC (International Olympic Committee) in 2016 is 206; the number of member nations of FIDE, the world chess federation, is 188. This compares with the membership of other sports as follows:

IAAF Athletics	215
FIBA Basketball	213
FIFA Football	211
ITF Tennis	211
FINA Swimming	207
IHF Handball	204
FIDE Chess	188
FISA Rowing	148
FIH Hockey	125
WR Rugby Union	103

Source: Wikipedia and official websites (2016)

2.2 Overview of the field of Chess and Education

As can be seen from the brief history, chess evolved along the Silk Road, and gradually circulated the world over the centuries. Chess is therefore much more ingrained in the culture of those countries located along this route.

In western nations, such as Australia, the culture of chess-playing is not so prevalent. Over the last 150 years, and from time to time, some schools have had keen volunteer teachers or parents running a regular chess club and have taken part in team competitions with other chess playing schools. Unfortunately, if the volunteer dropped out for any reason, the chess club died. This attrition has been a common theme in western culture.

In the last 20 years, many commercial 'chess in schools' enterprises have sprung up, with a resultant boom in the number of students learning and playing chess in individual and team competitions. Many students play chess, because 'they love it', and, according to their parents, some gain significant benefits such as social acceptance and boosted self-esteem.

Chess businesses emphasise the possible educational advantages for children learning to play chess and publicise the research on their websites for parents. However, the research is sometimes contradictory and is often criticised as lacking academic rigour.

Due to the availability of businesses devoted to teaching chess in schools, in Australia at least, the number of students learning chess and playing in inter-school competitions has shown a massive increase. In the early 1990s, the researcher looked for a school on the Gold Coast for his school to compete against, but very few schools had any involvement in chess. In 1995 a local competition took place involving 35 students from five schools. By September 2006, an Australian record of 1004 students played in a one-day chess competition on the Gold Coast. These students came from 41 different schools. Similar growth has been seen around most of Australia, especially in the major cities.

Chess is now one of the few sports in schools in Australia where students, as part of teams, can progress through regional and state competitions to national finals each year.

In Queensland, which geographically is a large state, regional winners from around the state fly into Brisbane each October for the state finals. This is a big commitment for schools and indicates that chess is regarded as a priority for them. It is unlikely that schools would make this commitment if they did not believe that the whole process was good for their students. However, it may not be for academic reasons; it may just be that schools think this type of competition is good for their students for other reasons - for example, to boost self-esteem. This growth has filtered through to the elite adult level, where more competitions than ever are being held, and the number of Australian Grandmasters has risen from two to seven since 2007.

Chess learning in schools can take various forms. Some schools just have a casual club, which may be run before or after school, or at lunchtime. It is likely the person who runs the club is a teacher, who may or may not have chess skills. In major cities, it is not unusual for a trained chess coach, supplied by a chess business, to hold weekly sessions, before or after school, for students whose parents pay a fee. The lesson would normally include a mixture of teaching a new idea or two, a chess activity, some social chess and perhaps a competition.

A small number of schools include chess as a co-curricular offering. Parents can elect to pay for their child to do small group chess lessons once a week during school time, in a similar way that music is taught in many schools. Other schools use budget funds to engage a chess coach to teach students in various year levels within the school curriculum. Many university students who learned chess at school, earn money as casual chess coaches in schools.

Students who play in inter-school competitions in Queensland and who reach a certain minimum standard earn a place on the Queensland Junior Ratings list. This gives an indication of playing strength when compared with approximately 3,500

other rated students. Some schools offer full or part scholarships based upon, in part at least, the Queensland Junior Chess Rating of students. These ratings are an accurate predictor of chess results between players aged between 5 and 17. The ratings list could be helpful in a longitudinal research study involving junior chess players.

The aim of the previous paragraphs is to demonstrate the growth that has taken place in chess in Australian schools over the last 20 years. While many students love chess, and many make it their ‘thing,' this in no way proves that chess helps academic scores or thinking skills. Some researchers have claimed that chess, even modestly, helps academic scores and thinking skills, but the number of unconsidered or unaccounted variables makes these claims difficult to defend.

The researcher conducted a mixed methods study via an online survey in 2016, entitled ‘Factors that Influence Australian Schools to Value or Otherwise the Teaching of Chess to Students.' This was offered to stakeholders from the researcher’s former business, namely Gardiner Chess. There was a strong positive response from school principals (52), deputies (18), teacher chess coordinators (52), teachers (11) and parents of students doing chess (109) who believed that by learning chess, their students received a wide range of benefits.

There were 315 responses to the survey, which included 34 research questions, and 834 optional comments which provided additional meaning. The strength and feeling in the response gave the researcher a strong incentive to pursue research in the field.

The perceived benefits included:

- General educational benefits
- Maths, Reading, Science and IQ
- Various Thinking Skills (Cognitive, Critical, Creative, Logical, Problem Solving)
- Concentration, Imagination, Patience, Planning

- Social skills, Responsibility for own actions, Win and lose with dignity, Life Skills, Self Esteem, Friendships, Cheap to Play (although regular chess coaching can be expensive for some)
- Children with Autism and Behaviour Issues
- Aboriginal and Torres Strait Islanders
- Children with Special Needs/Learning Difficulties

From the preceding information, it is observed that many people who are involved in chess in schools believe that chess has educational benefits for children.

But is this so?

For this literature review, over 170 papers in the field were studied, inserted into Endnote, and sorted via an Excel file. Keywords were assigned to each study. The most common keywords were: Cognitive Thinking 46, Maths 42, Problem Solving 25, General Educational 20, IQ 16, Memory 16, Neuroscience 14, Practice 12, Reading 12, Spatial Ability 12, Creative Thinking 9, Pattern Recognition 9, Perception 8, Critical Thinking 7, Strategic Thinking 7, Knowledge and Search 7, Gender 7, Logical Thinking 6, Social 6.

2.3 Overview of Research in the field of Chess and Education

The seminal work in the field of chess thinking is by Dr Adrian de Groot and is reviewed in the section ‘How Grandmasters Think - Chunking and Template Theory.' Another in the field of chess and education is arguably the Venezuelan ‘Learning to Think’ project (Tudela, 1984). However, for reasons given below, this is very hard to verify.

This researcher has been trying to contact Uvencio Blanco, one of the main contributors and former President of the Venezuelan Chess Federation, so far

without success. His name and contact details were kindly provided by Carolina Blanco (no relation), Women's International Chess Master, who advised

> '.. the person who can give you more data about that is Uvencio Blanco … he did some books related with the 'chess in the schools' program with data recollected in Venezuela and brought it to FIDE Chess in the schools, probably based on Tudela's pioneer studies.' (Blanco 2016, Personal email communication).

Unfortunately Tudela died in 2014.

Ferguson (1995) presented information from the project. Apparently, 100,000 teachers in Venezuela were trained to teach thinking skills by the Ministry for the Development of Intelligence. In the first year, 4,266 students from second grade took part in the 'Learning to Think' project. This Venezuelan trial used the Wechsler Intelligence Scale for Children to test whether learning chess can be used to develop the intelligence (IQ) of these students.

The researchers found that both males and females showed an increase in IQ scores in less than a year of studying chess. In fact, it was stated that most of the students showed significant gains after only 4.5 months.

> 'The general conclusion is that chess, methodologically taught, is an incentive system sufficient to accelerate the increase of IQ in elementary age children of both sexes at all socio-economic levels.'

Apparently, the Venezuela study included results regarding transfer of chess thinking skills to other domains (FIDE Report 1984, p74). FIDE is the world chess federation, and the report has long since been removed from their website.

In his paper 'Sport and Education, Transferability of Skills – An In-Depth Examination of Chess', O'Çonnell (1997) added that the Venezuelan study was also significant because results were assessed by sex and by socio-economic group. O'Çonnell is currently (2016) the Chairman of FIDE's Chess in Schools Commission.

The Venezuelan Experiment was judged as a success, and starting with the 1988-1989 school year, every school in Venezuela commenced chess lessons, (Linder, 1990). 'Chess is now part of the curricula at thousands of schools in nearly 30 countries around the world' (Linder 1990 p164).

This researcher includes the details of the Venezuela Experiment because they have appeared in many chess and education research projects. However, he has found no way of verifying the information provided by other researchers, particularly Ferguson, and thus places no weight on the findings. In fact, Ferguson himself at the time wrote that he had tried to obtain a copy of the research findings in English on several occasions, but was told that it had not yet been translated.

In his paper 'Chess in Schools and the Cognitive Capacities' (2009), Prof. Uvencio Blanco, former Chairman of FIDE's Chess in Schools Commission stated:

> 'We think that to provide strategies for optimizing the thinking of our students involves the improvement of two groups of fundamental skills in the development of the individual at an early age: the verbal ability (mother tongue) and numeracy skills (management of numbers, serials, etc..).' (Blanco C. pers. comm. 2009)

Educational research suggests that learning to think, learning how to speak and learning to reason, are processes that are closely related. In fact, nowadays no one doubts that one of the fundamental goals of education is to teach people to think and that to stimulate thinking and improve it in the classroom, it is necessary to promote the implementation of strategies to facilitate language and mathematical reasoning.

FIDE have a vested interest in the attribution of educational benefits of chess, and as such any information on the subject provided by FIDE needs to be treated with caution.

Apart from the concept of cognitive thinking and chess, more studies have been conducted in the field of chess and maths than in any other area of chess and education. The latest research is summarised under the heading **Chess and Maths** later in this review.

The following researchers have conducted studies concerning chess and cognitive thinking, which in most cases show some benefits regarding cognitive thinking for the chess learners. (Aciego et al, 2012), (Berkley, 2012), (Celone, 2001), (Christiaen, 1976), (Eberhard, 2003), (Ferreira and Pedro, 2008). (Forrest et al, 2005), (Frank, 1974), (Fried & Ginsburg, u.d.), (Gaudreau, 1992), (Gliga and Petru, 2014), (Hong and William, 2006), (Horgan and David, 1990), (Joseph et al, 2016),(Kazemi et al, 2012), (Kramer and Fillip, n.d.), (Laws, 2014), (Liptrap, 1998), (Martinez, 2012), (Rifner, 1992), (Sala et al, 2015), (Sala et al, 2016), (Sallon, 2013), (Sigirtmac, 2012) and (Tudela, 1984). Several of these studies also related to maths scores.

The amount of research in the fields of chess and creative and critical thinking is sparse, with some modest evidence of benefits in these areas. Amelkina (2009), Ferguson (1986), Sigirtmac (2012) and Frank (1974) conducted studies in the field of chess and creative thinking, with the Amelkina and Sigirtmac studies regarded as promising. The only studies relating to chess and critical thinking found by this researcher are Ferguson (1986) and Berkley (2012). The Berkley study was not particularly promising but did have some good qualitative information. The Ferguson study included a small high school group (15) of seriously strong chess players all with an IQ over 130, several of whom were national level players.

A detailed review of chess and its relationship to cognitive, creative and critical thinking is given under the heading **Chess and The Three Cs** later in this chapter.

None of the studies shown used the ‘ideal design’ recommended by Gobet and Campitelli (2006). That comprises a treatment group, pre-test and post-test, do-nothing and active control groups, random allocation of groups, different people for conducting the tests and treatments. Ideally this would involve the researchers’ and testers’ unawareness of the nature of group assignments, and participants’ unawareness of the fact they are taking part in an experiment. However, several researchers overcame practical difficulties and achieved statistical validity and reliability.

Gobet and Campitelli (2006), Bart (2014), Nicotera and Stuit (2014) and Sala (2016) have carried out substantial literature reviews and meta-analysis on chess and education.

Gobet and Campitelli (2006) were critical of most research concerning chess and education. They did compliment the Frank (1974), Christiaen (1976) and Fried and Ginsburg (u.d.) studies as being 'very well conducted, despite the enormous logistical difficulties that their authors are likely to have met'.

Apart from recommending the 'ideal' experiment, and emphasising meeting the publication standards of peer-reviewed journals, an important omission was found in virtually all studies. That is, the need to control for variables such as teacher effect (motivation and talent), classroom presentation, course design (what is specific to chess instruction?) and whether each child is doing some extra form of chess either inside school (eg lunchtime chess group) or outside (eg home or chess club). Where applicable, information regarding tournament play and chess ratings could be helpful. Even attribute variables such as age and gender, which should be regarded as essential, have been omitted from some studies.

Gobet and Campitelli (2006) point out that (in particular) randomisation in a school setting has potential ethical issues and is expensive to achieve, and an 'increase in the quality and quantity of empirical studies' is required. Further, they recommend using 'statistical means, as opposed to direct manipulation as in the ideal experiment, to control for variability in group allocation.'

Gobet and Campitelli also comment that large samples are required (at least several hundred participants) and variables, ideally measured over a long time. In this literature review, only five studies could be found that covered more than one year, and only two studies that covered more than two years: Margulies (1993) -2 years, Gaudreau (1992) - 2 years, Christiaen (1976) - 2 years, Martinez (2012) – 3 years and Kramer and Filipp (n.d. circa 2006) – 4 years.

Bart (2014) states that the research reported thus far provides evidence that chess training has salutary cognitive and educational effects among school-aged students. However, ‘the argument of Gobet and Campitelli (2006) needs to be considered before we can be confident that chess training is a valid means to improve scholastic achievement levels’.

The Nicotera and Stuit (2014) literature review was commissioned by the CCSL (Chess Club of St Louis). This review was segmented into three sections of academic rigour, with Tier 1 being the highest. Tier 1 was defined as an: ‘Experiment that controls for differences by random assignment at student, classroom, or school-level; or Quasi-experiment that controls for differences in groups by matching on student characteristics.'

Three Tier 1 studies indicated positive and statistically significant results. The first included 180 students in Iran (Kazemi et al., 2012), while the other two contained the largest samples of all the chess studies. There were 1,756 students in 123 classrooms in an Italian study. These were randomised to receive chess instruction (Boruch et al, 2011). A major experiment in England involved 483 students from 14 schools (Sallon, 2013).

Nicotera and Stuit recommend that future ‘chess in schools’ studies focus on academic measurements, such as standardised test scores. Such studies could include cognitive measurements, such as critical thinking, problem-solving and reasoning. Depending on school size, a new study may need to include ‘more than one school to obtain a minimum of 126 (or 350) students who can be randomly assigned to chess programs or the comparison group’. They also commented that some of the studies were not peer-reviewed and most did not involve randomised groups.

In the literature review of Sala et al (2016) they argue that ‘the higher the level of a skill, the more specific the features of a domain will be, and the lower the likelihood that there will be transfer of skills (Ericsson & Charness, 1994), because a large number of domain-specific perceptual chunks will be acquired (Gobet, 2015)’. He continues that most educational institutions need practical school activities that teach

and boost the transfer of skills. Chess is one such activity that has been used widely in schools.

Sala et al further argue that studies show that far transfer is needed for chess to transfer to other thinking domains such as cognition, and gives examples of studies where this is shown (Bühren & Frank, 2010; Unterrainer, et al, 2011). They surmise that it is possible that chess skills can be transferred to other domains, provided that chess is taught early on to children when academic and cognitive abilities are at the beginning of their development.

The meta-analysis of Sala et al investigated the potential benefits of chess for children on (a) mathematics skills, (b) reading skills, and (c) several cognitive skills (general intelligence, meta-cognition, attention/concentration, and spatial abilities). These were chosen because they were the three categories upon which chess-related research has been focusing.

Sala et al tentatively pointed to some positive findings of the benefits of learning chess for maths and cognitive thinking and gave similar suggestions as Nicotera and Stuit as to how research methodology should be improved.

Sala and Gobet (2016) comment:

> 'Another important goal is to identify the specific characteristics of chess that might improve children's abilities, and which abilities they foster (e.g., attention, spatial abilities, quantitative reasoning, or metacognition). For example, is it the diversity of pieces on the board that helps maintain attention? Does the movement of the pieces help to boost visuospatial abilities? Does chess ideally combine numerical, spatial, temporal, and combinatorial aspects? Does chess promote a better and more conscious way of thinking?'

These three literature reviews/meta-analyses were most helpful for this researcher in developing his research question. Gobet and Campitelli pointed out the need to control for variables, to have large groups and to carry out a long-term study. Sala et al pointed out the difficulty of transfer of skills between domains, but they believe it is possible when children are taught chess early on. Many of these studies are individually reviewed by this researcher in the chess and maths, and chess and cognitive thinking sections.

2.4 Chess and Maths

The *London Chess Conference*, supported by Chess in Schools and Communities, has been held annually in December. In the first year (2013) the conference examined benefits to schools, in the second the relationship between chess and mathematics and in the third the field of chess and education, including researchers in this discipline.

At the 2015 conference, a paper was commissioned and presented by CCSCSL (Chess Club and Scholastic Center of Saint Louis). This literature review was cited as Nicotera and Stuit (2014) (see previous section 2.3).

Nicotera and David (2014) – *Literature Review of Chess Studies*.

The researchers identified 51 studies involving chess and maths, many of which this researcher has included in the current literature review. Although the study could include games similar to chess, none were found that met the intervention criteria. Twenty-four of the 51 maths and chess studies met the criteria for inclusion in the review.

Criteria for inclusion were (broadly):

> Intervention to include chess as a major feature
> Student Level Outcomes with evidence of validity and reliability
> Control group of non-participants
> Student ages 4-18 (or Pre-K-12)
> Study conducted 1970 to July 2014

The 24 studies were then categorised into tiers 1, 2 and 3, with just 8 making tier 1 category. The criteria for tier 1 were:

> ‘Experiment that controls for differences by random assignment at student, classroom, or school-level; OR
> Quasi-experiment that controls for differences in groups by matching on student characteristics AND reports group equivalence on pre-test results.’

The researchers found that

> ‘Results from the literature review were categorized by the quality of the study design and organized by whether the studies examined after school or in school chess programs.
>
> The main findings from this literature review are 1. After school chess programs had a positive and statistically significant impact on student mathematics outcomes. 2. In-school chess interventions had a positive and statistically significant impact on student mathematics and cognitive outcomes.
>
> While the two primary outcomes listed above are based on studies that used rigorous research design methodologies, the results should be interpreted cautiously given the small number of eligible studies that the pooled results encompass (two high quality after-school studies and seven high quality in school studies)’.

None of the studies looked at most of the possible variables. However, most of the tier 1 studies could be regarded as promising.

The Education Endowment Fund (EEF) in the UK is an independent charity that broadly aims to assist disadvantaged children by identifying and evaluating educational innovations and encouraging schools, government, and charitable organisations to adopt innovations found to be effective. The Fund carried out a ‘chess and maths in schools’ project in the 2013/2014 school year and had it independently evaluated by a team of researchers from London University.

Jerrim et al. (2016) - *Chess in Schools Evaluation Report and Executive Summary*

The project involved 4,009 grade five students and looked at whether there was an improvement in maths attainment one year later in June 2015.

The conclusions were:

> ‘There is no evidence that the intervention had a positive impact on mathematics attainment for the children in the trial, as measured by Key Stage 2 scores one year after the intervention ended. The same is true for science and reading.

> There is no evidence that the intervention had a positive impact on Key Stage 2 scores for children eligible for free school meals (FSM)
>
> Although a current school teacher is allocated to every chess class, it is desirable for the tutors themselves to have strong class management and teaching skills. Without these, it was difficult to ensure that all children were suitably engaged in the chess lessons
>
> For successful implementation, class teachers need to work closely with the tutor and actively contribute to the intervention. It was felt that classes were less effective if the teacher did not actively take part, or was present only at the beginning and end of the class
>
> Half of the pupils who participated in the trial said that they liked the chess lessons a lot, and only 8% reported that they didn't like them. School teachers were very positive about the intervention and its impact on pupils' skills and behaviour.'

The independent evaluation team concluded 'There were no substantial threats to the validity of the results.'

In this researcher's opinion, this study goes further than many of the others in accounting for most variables.

The CCSCSL and EEF papers reflect the latest research in the field of chess and maths in education, but with different findings. They indicate that while the quality of the research has improved in recent years, there are still some concerns.

The researcher has reviewed several of the papers relating to chess and maths in the Chess and Cognitive Thinking section and is satisfied having read all the available literature in the field of chess and mathematics, that no study has fully examined the many variables involved.

2.5 Chess and ADHD

ADHD (Attention Deficit Hyperactivity Disorder) is common in people with autism (source The National Autistic Society, UK).

This researcher observed several children whose parents advised that their child had ADHD when enrolling at his chess centre between 2003 and 2011. He strongly believes that he saw a common pattern in some of these students. The children quickly started to enjoy the game, they liked the rules and the confines of the chess board, they became good at the game, their self-esteem went up; they made friends, and their behaviour improved.

Several parents (predominantly mothers) were effusive in relating the benefits that learning chess had given to their child. Not only that, they were quite certain that learning and playing chess was the main, or only reason for the turnaround in the child's behaviour. However, if a child with ADHD showed that he or she did not like the game, it was unusual for that child to change.

Blasco-Fontecilla et al (2016) - *Efficacy of chess training for the treatment of ADHD: A prospective, open-label study*

Forty-four children aged 6-17 diagnosed with ADHD participated in this Spanish study. The students undertook an 11-week chess training programme.

The paper states that 'central executive dysfunction is core to ADHD,' and 'several executive functions are needed when playing chess'. The researchers hypothesised that children who spent more time playing chess or children of higher intelligence were most likely to display improvements in ADHD symptoms. Parents completed the Spanish version of the Swanson, Nolan and Pelham Scale for parents (SNAP-IV) and the Abbreviated Conner's Rating Scales for parents (CPRS-HI). Results suggest a large effect of decreasing the severity of ADHD. Furthermore, the researchers found a correlation between intelligence quotient and SNAP-IV improvement ($p < .05$).

The researchers concluded: 'If our results are replicated in better-designed studies, playing chess could be included within the multimodal treatment of ADHD'.

The researchers put forward possible advantages of chess training for ADHD treatment.

> Cheaper than psychotherapies
>
> No side effects
>
> Play is critical to the social development of children
>
> 'The key factor for play-based interventions is their ability to capture the motivation of children with ADHD' – 'motivation is critical for the success of any treatment.'
>
> Most of the children involved in the study were highly motivated to play chess, with less than 5% discontinuing

Chess is not recommended for children who spontaneously indicate they do not want to play chess.

The researchers are hoping that the results will be replicated in more robust studies.

El Daou et al. (2015) - *The Effect of Playing Chess on the Concentration of ADHD Students in the 2nd Cycle*

This study hypothesised that chess improves concentration period and listening language skills. Many parents would like an alternative to medication, and if effective, learning chess would be a good outcome.

> 'The sample was chosen from two schools with inclusion; students received chess training twice per week. Pre and post measurements of Conner's Teachers Rating Scale: Revised Long version, concentration tasks, and scores of school language listening tests were the data collection tools of the study.'
>
> 'Results showed improvement in concentration skill and period, and in listening score.'

The paper states that interventions involving music, physical education, and special diets have been effective in some cases of treatment for ADHD.

Fourteen students with ADHD were taught chess for a total of four months, twice a week in the 2012-2013 and 2013-2014 school years in Lebanon. All students had an

average IQ, struggled to stay focused and attentive in class and had a similar level of severity.

The researchers found that students stayed longer on task and maintained focus before exhibiting unacceptable behaviours. They also showed an improvement in concentration and listening scores. They concluded that while the results were very promising, there are difficulties generalising the findings, as the sample was not representative.

2.6 Chess and Miscellaneous Matters - Aboriginal and Torres Strait Islander Students

This researcher has been unable to find any research about possible benefits of learning chess for Aboriginal or Torres Strait Islander children.

The researcher's interest was aroused by a teacher from a school from northern NSW who brought students to a chess tournament held just over the border in Queensland. She stated that she had several Aboriginal students at her school. She said they seemed to respond particularly well to chess and seemed to be better at pattern recognition.

Bearing in mind 'feel good' movies involving true-life stories of low socio-economic black students in Harlem, and the *Queen of Katwe* story from Uganda, where students became chess masters, it is feasible that chess could be taught in Aboriginal communities, with a possible pathway out of poverty.

2.7 How Grandmasters Think; Chunking, and Template Theory

The seminal work in the field of chess thinking is by Dr Adriaan De Groot, at the time an active psychology student at the University of Amsterdam and an international chess player. He conducted sessions between 1938 and 1943 with some

of the world's greatest chess players of the time: Alexander Alekhine, Max Euwe, Paul Keres, Reuben Fine, Salo Flohr and Savielly Tartakower and others. De Groot wanted to answer the questions 'what is so special about the thought processes underlying the skilled chess players' choice of a move? And why do masters find the good moves that patzers overlook?'

De Groot's original doctoral thesis (in Dutch: Het denken van de schaker, 1946) was published as a limited edition and has been hard to find. In 1965 it was translated into English, and then updated and released as the book *Thought and Choice in Chess* (De Groot and Dingeman, 1978). The preface by Dr Sijbolt Noorda, president emeritus of the University of Amstersdam, noted that 'the book is a milestone marking the transition of the psychological study of genius to the early beginnings of empirical cognitive science'. 'His thesis was viewed as a breakthrough in the development of AI models of thinking'. 'Until this very day, the Dutch school system relies on aptitude tests proposed by De Groot in his book on selection processes in education'.

De Groot interviewed the chess masters and average club players at length. He gave them positions taken from various tournament games and then questioned them about their thought patterns leading up to their choice of move. De Groot found that the thought processes of the Grandmasters and club players were quite similar. However, he discovered that club players tended to waste time on unimportant information.

The main difference between Grandmasters and club players was in the speed in recognising critical components in the position. In fact, in most cases, Grandmasters had settled on the most likely move within the first few seconds of analysing the position.

De Groot found that Grandmasters followed processes like these before making a move:

Understand what is important about the position

Analyse most likely concrete variations and candidate moves

Decide upon the most probable move

Check the validity of the move

De Groot (P334) also made another fundamental observation that eventually led to the 'chunking' and 'template' theories proposed by Chase et al (1973).

> 'It is only possible to perceive relatively large complexes as units or whole because they are typical wholes to the perceiver: in origin, function, significance, value and/or prescribed treatment. It is because … larger units can be perceived as such and thus, that the subject is able in such a short time span to take in the complete position.'

De Groot, amongst many others, also made two other interesting statements: P335

> 'chess thinking is typically non-verbal. The chess player is concerned with moves on the board, with movements and manoeuvres, with spatial relationships, and with dynamics of captures, threats, and control – all of which can be objects of perception, imagination and thought, without any dependence on verbal formulations and concepts'. 'Illiterates and deaf-mutes can learn to play chess; strong natural players who never studied any theory still exist.'

De Groot's findings that 'chess thinking is typically non-verbal' and involves 'spatial relationships' has important implications for gender issues in chess, as discussed later in this paper.

Also on P338

> 'in the chess master's empirical, specifically inductive way of thinking, there are no primary principles from which deductions can be made; nor are there any empirical rules without exceptions.'
>
> 'A dogmatist is just as unfit for playing chess as he is for leading a dynamic enterprise.'

Children just starting out in chess are taught basic opening 'principles' such as: to develop minor pieces quickly, castle early, control the centre of the board and don't move the queen out too early. They are also taught that all 'principles' need to be

broken sometimes, depending upon the position on the board. Sometimes, perhaps lazily, chess coaches refer to ‘principles’ in this context as ‘rules'. From the point of view of children with ADHD or autism, it is important to refer to these principles as just that, not rules. In their way of thinking, ‘rules’ can never be broken.

Though Jongman’s (1968) paper was not published his ideas were eventually included in the work of de Groot et al, *Perception and Memory in Chess* 1996. Jongman agreed with de Groot’s thesis, and emphasised that the key attributes for chess masters are knowledge and experience, rather than calculation and memory. Chess masters showed remarkable speed of judgement when memorising ‘normal’ chess positions seen for only a few seconds, but when given random chess positions, they were no better than average players.

Chase et al (1973) developed ‘chunking’ theory. This is how a chess master can remember a whole cluster of pieces, providing it is from a normal (not random) chess position. This corroborated de Groot’s description ‘It is only possible to perceive relatively large complexes as units or whole because they are typical wholes to the perceiver’.

Based upon pattern recognition, chunking is a major resource for recalling a position. While chess masters excel in this aspect of chess, average players also can, but to a lesser extent. For example, most juniors who have received coaching, as well as average club players, can easily recall the set-up of the fianchettoed bishop on g2 in combination with the associated pawns, rook and king castled on the kingside. It is only because of their extra knowledge and experience that Grandmasters particularly excel at this.

They argued that at least ten years’ study was required for a player to reach Grandmaster level. However, as we now know one child under the age of 13, and six children under the age of 14 achieved the Grandmaster title. It is therefore possible that a player can gain the necessary knowledge and experience in approximately eight years. This is relevant later in this study when considering whether Piaget’s Stages of Cognitive Development can be accelerated.

Gobet and Simon (1996) further developed chunking theory, introducing template theory. Templates are slots within chunks, where additional information can be stored. The chunking can, for example, be individual openings, and the slots can be information about a particular position within the opening. These may take many years to develop. Club players may have just a few available, while Grandmasters may have several thousand.

De Groot also made a comment about possible gains for school students suggesting ‘low-level gains’, such as improvement in concentration, learning to lose, learning that improvement comes with learning, or interest in school in low socio-economic areas; and ‘high-level gains’, such as increase in intelligence, creativity, and school performance.

De Groot, together with Chase et al, provided a solid platform as a growing number of researchers joined the field of chess and education, and specifically aimed to determine whether learning chess has any educational benefits for school students.

This researcher observes that Grandmasters’ play in the first (say) 15-20 moves is often purely rote memorisation of opening theory. Once out of opening theory, the Grandmaster will often go into a deep ‘think’ and consider the position firstly from a tactical perspective, and probably longer to develop a strategy. The Grandmaster will rely on taught skills in such matters as pawn structure, time, space, piece development, and control of squares.

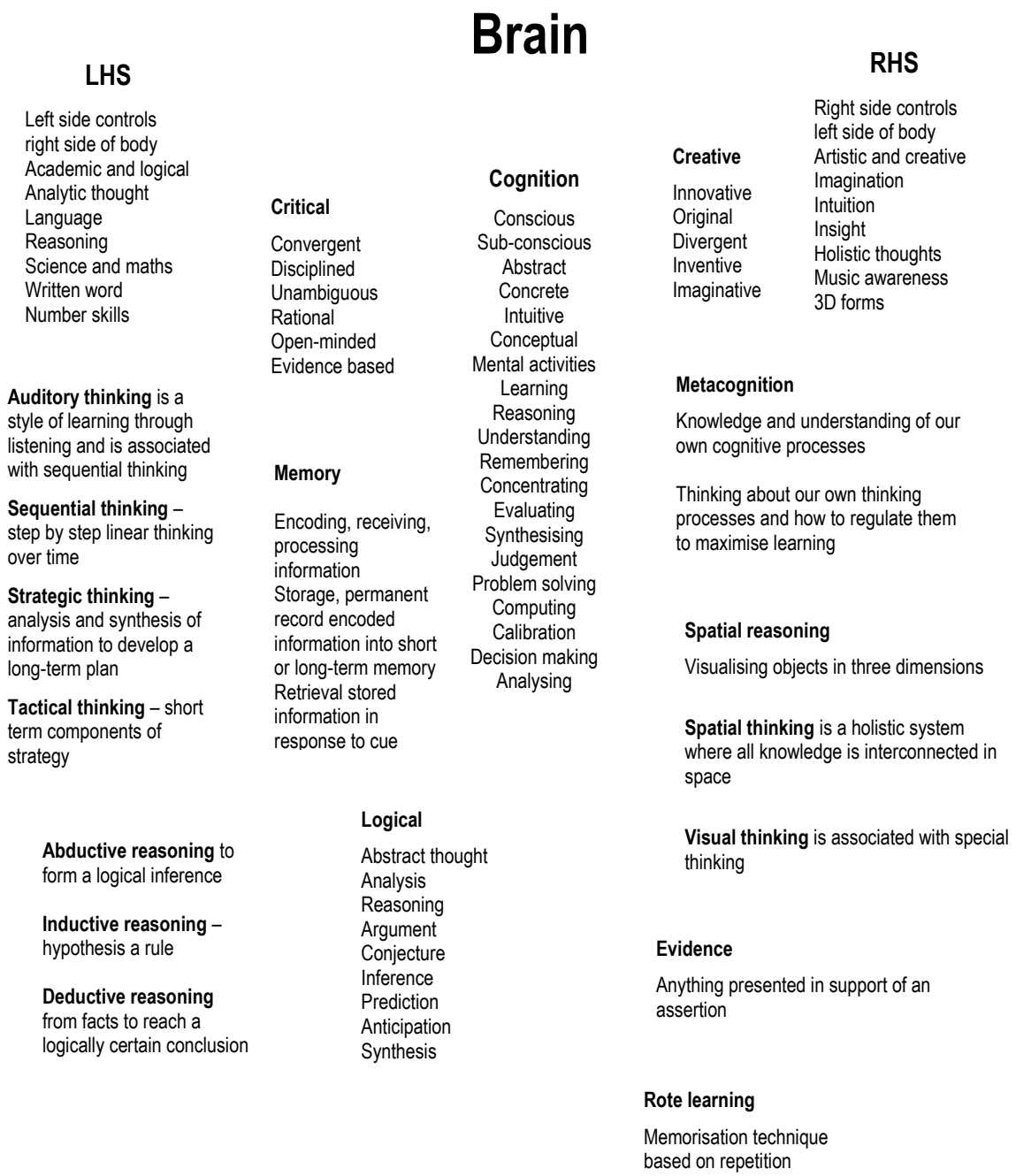
In general play, the Grandmasters will always look for tactics and play to a strategic plan, but they will often make a move and say afterwards ‘it just felt right.' Intuitive thinking can be based upon pattern recognition and a whole multitude of past experiences.

Some Grandmasters prefer tactical melees, where short-term tactical calculation is paramount, while others prefer quiet strategic positions. Those who prefer tactical games are likely to use up a lot more energy, while Grandmasters who favour

strategic positions, gradually improving their position, are likely to be less tired towards the end of tournaments that can last for many days.

Figure 1

Gardiner Thinking Chart



Wishing to know more about how Grandmasters think during chess, the researcher sketched a thinking chart (Figure 1) and asked seven of Australia's Grandmasters to reflect on this, and how they think in long games of chess. Then they were asked to list the skills outlined on the chart which they use when playing a long game of chess. 'Long games of chess' was specified, because chess players use a different skill set for short, lightning or blitz chess games.

Grandmaster 1 responded:

> The skills on the list that I don't use in longer games are: Language, Written, Auditory (any), Music (any), 3D forms, all the rest are used in some form or another.

Grandmaster 2:

> It's easier to eliminate the skills you don't use - all the ones relating to sound or writing. I also don't know quite where 3D forms would fit into playing chess. The rest would all be useful, in greater or lesser degrees. I'd like to think artistic and creative thinking was involved but in a sporting contest, it would seem to be a by-product of trying to win rather than a skill to be used. Metacognition is, similarly, not necessary but would probably improve results if used. All the cognition categories seem very familiar and would all be used all the time while playing tournament chess.

Grandmaster 3:

> Here are the list of thinking skills I believe I use during long time control games: Critical: Rational, Open-Minded Memory: Encoding receiving processing information, Storage permanent record encoded information short or long-term memory, Retrieval stored information Cognition: Conscious, Intuitive, Concrete, Understanding, Remembering, Concentrating, Problem Solving, Calculating, Decision Making, Analysing Logical:, Analysis, Reasoning, Prediction, Anticipation, Conjecture, Synthesis Creative:, Original, Imaginative, Divergent Metacognition (I don't use these during the games but certainly whilst training for them): Thinking about our own thinking process, and how to regulate them to maximise learning, Rote Learning , Memorisation technique based upon reputation.

Grandmaster 4:

> Essentially, I use all of the skills you note in a long-time-control game - I believe very strongly that decision-making in chess, and even the sport in general, involves the entire brain. I think even more could be added to the existing list.

Grandmaster 5:

To be honest, I can make an argument for almost every one of thinking skills listed in long games of chess. Those that I couldn't were argument, synthesis, calibration, and computing. The last I'm taking to be distinct from calculation. Also, while the sub-conscious must be involved in chess thought, it is hard to quantify!

Grandmaster 6:

For "familiar" positions memory (recall of similar positions from own past experience or others I have seen) and cognitive skills such as comparison and reasoning will often suffice for move selection. However, in my experience rote learning is rarely useful as even if the exact position comes up unless I have looked at it recently (say in the past 1-2 weeks) I am unlikely to remember any sort of detail. The general direction of play and broad assessments in familiar positions are much easier to remember and stays with me a long time.

If the above process does not produce a satisfactory result then I think there will be more creative input and if time allows will try and widen the search by looking at a range of moves. This creative process feels quite abstract to me and I am not sure it's open to much rational reasoning. I am pretty sure this "black box" process would likely result in a different move by the same player as for example happens when you have reached a position previously but don't even remember what you played last time until your opponent tells you after the game!

In all cases simultaneously as move selection, short tactical/strategic calculations and assessments are usually happening at the same time which very quickly filters out a large range of moves. This filtering process is very useful as otherwise there are too many lines to consider and it becomes chaotic. I think visual/spatial reasoning is very important when calculating, most strong players I have seen have a natural grasp for blindfold games and calculating quite accurately when shown a position and then asked to calculate with no sight of the board.

At the same time as above intuition is always playing a guiding hand, very often it not only gives you a intuitive "insight" into complicated variations and in strong players it will also suggest what give good practical chances. I am sure that raw emotions also play a large hand when it comes to move selection, there are so many occasions when we choose aggressive looking moves because we are in a attacking mood or shy away from certain moves because of fear. In general, although emotions can help, I feel a strong player is generally able to maintain it at a controllable level as relative objectivity is most important in high-level play.

Totally unfamiliar positions (such as chess studies) are generally very difficult. Sometimes I do attempt a bit of a brute force search for the best move if it seems vaguely possible (if there are relatively few pieces on the board). If it's totally chaotic I am likely to calculate some short lines and then guided by it and intuition. Here it's kind of difficult to make out a very logical

decision process as there are nothing to be guided by. On a good day when motivated then hopefully creative input will produce interesting ideas.

A position with little time left on the clock - When having say less than say one minute left in a relatively complicated position, here basic skills like noticing short-term tactical threats prevail, there is limited sense of the bigger picture such as general positional assessment, anticipation, reasoning – the mind is focused on not losing on time and falling for something simple. A bit like diving headlong across a multi-lane highway with no pedestrian crossing – the mind is purely occupied on not being hit, there is no real sense of direction or purpose. However, repeated training under time pressure can improve with ability to cope and some players are able to play 1 min games on quite a decent level.

Grandmaster 7:

During a game of chess, I need to utilise different parts of my brain. In the opening phase, I try remembering my lines and try to check if the move I want to play is the correct one. Just after the opening phase has been completed and a new position for me has arisen, I try to remember key ideas and patterns of what I want to achieve. These patterns have been formulated from looking at countless games of strong players and of my own. I try to use these patterns to find plans, ideas and manoeuvres. If the position is very tactical, I will concentrate more intensely to not miss anything, whereas if the position is positional, I will try to find which plan or idea is the most suitable, or how to prevent my opponent from fulfilling his plan (prophylaxis). Intuition has a great role especially when positions are too complicated, or I have too little time to think. Intuition usually allows me to go in the correct direction.

After the middle-game phase has been played out, the endgame phase begins. The endgame can be divided into two categories: complicated endgame positions and common-knowledge endgame positions. In complicated endgames, there are still quite a few pieces on the board, resulting in positional decisions having to be made of which pieces to exchange, to create a pass pawn, to activate the king, etc. After quite a few more piece exchanges have taken place, the endgame becomes very theoretical. Remembering key ideas and motifs is very important and it comes from reading endgame books. The endgame phase can be said to be a mix of the middle-game and opening phases. Depending on the position, different areas of the brain will be used.

2.8 - Thinking Skills for School Children

In this section this researcher has relied heavily on a wealth of ideas obtained from the book *Developing Thinking; Developing Learning – A Guide to Thinking Skills in Education* by McGregor (2007). The author, Professor Debra McGregor, is a former

high school classroom teacher from England and is currently (2016) Professor of Education at the School of Education, Oxford Brookes University, Oxford, UK.

The following are a series of observations and quotes from the book, where she acknowledges the work of various authors. These indicate a whole series of interactions between learning and thinking skills which could be strongly linked with learning to play chess. The researcher is particularly mindful of one quote - ‘The issue of metacognition and transfer of knowledge from one field to another is seen as difficult.'

McGregor (p 125) quotes from the work of Swartz et al. (1998: 528) that:

> ‘Infusion is the approach teachers use when blending specific instruction about thinking skills and processes with content instruction. It involves pedagogic approaches that enhance students’ thinking and comprehension of the subject matter’

She mentions that Fisher (1997: 4) describes how to use different cognitive skills (ie, critical and creative thinking) through playing games. This can be fun, motivational, provide a variety of learning material and importantly help develop a comprehensive set of thinking skills. In particular, Fisher suggests that the games can be used for thinking about the game in detail (easy, hard, rules, can it be categorised etc), thinking in the game (strategies, tactics, how to win etc) and thinking through the game (why were you successful or unsuccessful, was your strategy good etc). Fisher recommends the ‘community of enquiry’ approach where time is made to discuss, think, review and raise questions. (p144).

‘Critical thinking is evaluative or reflective consideration about the validity, nature or substance of an idea or proposition.' ‘Standard intelligence tests measure this kind of convergent thinking' (p172).

> ‘Creative thinking is the generation or suggestion of a unique or alternative perspective, the production of an innovative design or a new approach to a problem or artistic challenge.' (p172).

> ‘In problem-solving situations learners may see-saw between critical and creative thinking, going back and forth in the generation of ideas, critical reflection of suggestions and subsequent refinement, modification or regeneration of further innovations until a suitable solution is reached.' (p173).

McGregor believes that when critical and creative thinking are combined, metacognitive processing is required. She argues that metacognition involving thinking processes can ‘render the creative or critical aspects more explicit’ (p173).

Puccio and Murdock (2001) were interested in how creative thinking is closely associated with the process of creativity. They believe that it relates to what needs to be done for cognitive skills to progress from the perception of a problem to an outcome (McGregor p174).

Torrance (1974: 8) produced a definition of creative thinking:

> ‘A process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results’ (cited in McGregor p174).

The standard tests of creative thinking are the Torrance Tests of Creative Thinking.

Puccio and Murdock (2001) argue that creative thinking and problem solving go together in the workplace. Employers encourage staff to come up with creative solutions to problems for the benefit of business. This is often thought of as innovative thinking. They believe that creative and critical thinking are inextricably linked in solving workplace problems (cited in McGregor (p174).

McGregor believes that ‘puzzles, games, and many activities may be used to highlight and emphasise the nature of critical thinking.' ‘The cognitive processes and the problem-solving strategies that are developed and used, become clarified through metacognitive discussion.' (p198).

Regarding the development of metacognition, McGregor argues that in educational programmes used to enhance thinking skills, several researchers have found that a focus on metacognition has been shown to have positive results for the learning experience of students (p211).

Hartman 1998 is of the belief that:

> 'Metacognition is especially important because it affects acquisition, comprehension, retention and application of what is learned, in addition to affecting learning efficiency, critical thinking and problem-solving. Metacognitive awareness enables control or self-regulation over thinking and learning processes and products' (cited in McGregor: 211).

As previously indicated, McGregor believes that the issue of metacognition and transfer of knowledge from one field to another is problematic and supports the argument of Desforges and Lings (1998) that 'transferring knowledge from one context to another is not straightforward'.

Shayer and Adey (2002) indicate that the 'nature of the link between situations must be cognitive so that the learning is not fixed to one task'. The teacher needs to get students to reflect upon their prior experience and knowledge to identify other situations where the thinking would apply. 'The aim is to ensure the contexts that students connect are more relevant to them than the teacher' (cited in McGregor p221).

McGregor (p246) argues that 'in problem-solving situations, there is much critical thinking. More creative thinking is needed when possible tactics, methods or approaches to the problem are developed and proposed'. The constant weighing up and synthesising of ideas can lead to more innovative ideas, which Fisher (2001: 13) describes as critico-creative thinking. Because critical thinking can sometimes be thought of as uninteresting, this contribution signalled a new, more exciting approach.

McGregor (p48) provided these ideas regarding problem-solving for students:

A problem-solving approach in learning promotes:

- Understanding of the subject matter
- Motivation, engagement and intrinsic interest in the subject matter
- Appreciation of the (cognitive) processes and thinking involved in solving open-enquiry
- Recognition that there is often no, one, correct answer; that some solutions, however, are better than others
- Problem-solving offers potential for application of a wide range of cognitive skills and ways of thinking (including critical, creative and metacognitive)
- The nature of tasks that pupils are given to solve, can constrain or provide wide potential for the development of thinking skills.

While McGregor does not refer to ‘chess’ once in her book, her ideas about thinking skills and learning in the classroom, leads this researcher to suggest that chess could be eminently suitable as an extra-curricular offering in schools.

The educational benefits for students in learning chess at school has been put forward by many researchers and is the subject of an increasing number of studies. Whatever the outcome of this study, and others, it is easy to argue that a significant number of students make chess their ‘thing,' and gain significant self-esteem from their involvement.

It would also not be difficult to argue that chess is an ideal academic, competitive sport for students to give balance to the many opportunities for students to play the ‘sweaty’ sports. In this researcher’s experience, there would be few that dispute the ideas that competitive chess players learn to win and lose with dignity and display good sportsmanship.

The difficulty of transfer of skills between domains was repeatedly emphasised in McGregor’s book. Cognitive, critical and creative thinking are keywords and appear prominently in the book.

2.9 - Chess and The Three Cs

Children's thought processes are of interest to the researcher; particularly cognitive, critical and creative thinking. There have been many published studies concerning chess and cognitive thinking, but few connecting chess and critical thinking, or chess and creative thinking. However, education researchers sometimes link the three together.

This section studies the main projects found in this literature review.

2.9.1 Chess and Critical Thinking

Only two studies relating to chess and critical thinking were found. The study of Berkley (2012) did not concern children. Twelve adult students participated as the chess group. There was a control group of 12 who had no experience of chess. The chess group attended chess lessons for ten weeks, for 80 minutes a week and had not played previously. The quantitative results indicated that chess improved mathematical ability, but not critical thinking ability.

For the qualitative phase of the study, the experience of six students was used to understand their understanding of developmental mathematics as well as how they perceive their abilities to play chess and think critically.

Qualitatively, the students perceived there were relationships between chess and critical thinking.

The other study, by Ferguson (1986) involved 94 high school students, who were divided into three groups doing chess, computer, and neither of these. The chess group had two hours of chess per week for 32 weeks. There were only 15 students in the chess group, they each had an IQ of 130+, and all were already strong chess players. The small sample size, exceptional group IQ, and no random selection should be regarded as weaknesses in the study. However, the researcher concluded that chess had a definite impact in developing both critical and creative thinking skills.

It appears that a study relating to chess and critical thinking involving primary students, and measuring further variables, would be warranted.

2.9.2 - Chess and Creative Thinking

In the Zaire study, Frank (1974) studied whether learning chess could influence the development of abilities in one or more of a) spatial aptitude, b) perceptive speed, c) reasoning, d) creativity, or e) general intelligence. Ninety students from 4th year of secondary, who were new to chess, were involved.

There was a significant correlation between the ability to play chess well, and spatial, numerical, administrative-directional, and paperwork abilities. Other correlations obtained, including creative thinking, were all positive, but only the those mentioned were significant. The researcher claimed that this finding tends to show that ability in chess is not just because of one or two abilities in an individual, but several aptitudes working together.

The Ferguson (1986) study involved 94 high school students with high IQs and very strong chess players, so inferences cannot be drawn for the general chess population. The researcher concluded that chess had a definite impact in developing both critical and creative thinking skills. As previously indicated, the small sample size, exceptional group IQ, and no random selection were weaknesses in the study.

Amelkina and Ala (2009) investigated the creative thinking of 11 to 15-year-old chess players, as well as their intelligence and achievement. Scores were obtained for fluency, flexibility, originality and elaboration. The chess group comprised 56 students, with 60 in the control group. The researcher concluded that there was a statistically significant increase of nonverbal creative thinking, fluency and originality amongst the chess group in 2006/2007. The researcher also stated the results indicate that learning chess helps develop cognitive abilities amongst children, creative divergent thinking being one of them.

An Investigation on the Effectiveness of Chess Training on Creativity and Theory of Mind Development at Early Childhood by Sigirtmac (2016) was an interesting study, and the only one found by this researcher involving primary students, chess and creative thinking. The research involved 87 children included 41 children (average age 5 years 8 months) in the chess group and 46 children (average age 5 years 9 months) in the no chess group. The chess group was taught chess for two hours per week, for at least seven months. There was no pre-test, and tests were administered verbally.

The findings indicated significantly higher scores in Creative Thinking and Theory of Mind scores for the chess group over the no-chess group. Children in the sample group didn't have any differences in cognitive, language, social-emotional and psychomotor development, whereas creative thinking and Theory of Mind skills of children playing chess were found to be significantly different from other children. Chess is thought to support these skills in students. The fact that there were no pre-tests, a relatively small number of participants, and there was no mention of attempts to measure extraneous variables, can be seen as weaknesses of this study.

However, this study is quite promising. This researcher believes that another study involving a greater number of students from all primary year levels, with pre and post-tests, and a detailed analysis of several variables is needed.

In the field of chess and creative thinking, there is quite a wide range of interpretations of the definition of creative thinking and innovative thinking. Generally creative and innovative thinking are very closely linked. The main difference seems to be that innovative thinking is regarded as creative thinking in the context of making businesses more efficient or profitable.

Wikipedia defines the chess term 'novelty' as a move in chess which has never been recorded previously. Chess players often refer to a novelty as an innovation. Chess 24 https://chess24.com/en/search?q=novelty describes a novelty as 'the first move in a game of chess that has never been played before. At a professional level such moves are often backed up by deep analysis and aimed at surprising one's opponent.'

In the official world of chess, there is a ‘novelty of the year’ award. The winning novelty is usually a move that departs from recorded theory, or at first glance seems extremely improbable. The researcher regards a novelty in chess as meaning an innovation involving any principle, opening or move that departs from and improves existing theory.

Importantly, what may be an innovation for one player, may not be for another. An experienced player, for example, may see a fork (which is a tactic) that is due to prior learning, prior experience and/or pattern recognition, and which is not, in this context, an innovation. Another player, who has never been taught the tactic, works it out, and in this context it is an innovation.

Chess players all over the world would, logically, reach positions on (say) move 40 (when there are still several pieces left on the board) that have never, ever been reached before in a game of chess. The move they then play may be decided by a mixture of prior experience, pattern recognition, and prior learning. As the number of pieces left on the board becomes small, then it is easier for the player to rely on learned endgame theory.

The researcher argues that the possibility for a chess player to be creative or innovative decreases over the time they are taught, as they recognise patterns or rely on past experiences.

To summarise, there are two types of innovation. There is thinking that is innovative to the learner, and there is empirical innovation which is improvement to established chess theory.

If this thought process is correct, then it should be possible for someone new to chess to think innovatively, but much harder for an expert.

2.9.3 - Chess and Cognitive Thinking

Studies relating to chess and cognitive thinking have been split into five groups: Economically disadvantaged; Behavioural problems 5-11 year-olds; At risk of academic failure students with learning difficulties of 5-11 year-olds; Cognitive development of 11-15 year-olds; Cognitive development of 5-11 year-olds.

2.9.3.1 - Economically Disadvantaged

The conclusions drawn from the verbal, quantitative and nonverbal reasoning tests results by Eberhard (2003), indicated that chess instruction, overall, had the greatest impact on grade 7/8 students not identified as economically disadvantaged. These students showed statistically significant improvements in verbal, nonverbal and quantitative reasoning measurements. The 13-week study was very short, there was no 'do nothing' control group and there was little attention to other variables.

In the Garcia (2008) study, 27 mainly economically disadvantaged fifth-grade students, undertook a single academic year of school chess club participation, with a control group who did not. The results indicated no statistically significant difference in maths or reading scores for the two groups in before and after testing. It is unclear whether those participating in the chess club received any chess coaching. The researcher did not appear to obtain data for gender, age, socio-economic status or other variables.

A group of 48 grade 6 chess students from a rural area in India, in a study by Joseph et al (2016), undertook chess once a week for a year, and 52 in the randomly selected control group did no chess. The chess group also participated in regular chess tournaments. The results of the paired samples t-test analysis showed that there was a significant increase in scores for all subjects except Tamil, and the increases were greater for the chess group than the control group, especially in English, social studies, and science.

The researcher concluded that chess is a game that can be used to develop cognitive skills in children. There was no active control group, and the chess group was not

randomly chosen. No allowance was made for variables, including, for example, gender.

The Eberhard study appeared to show that students not economically disadvantaged showed greater improvements in thinking skills than those identified as economically disadvantaged. The Garcia study showed that the chess group of economically disadvantaged students did no better in maths and reading than the non-chess group. The Joseph study showed a significant improvement in all subjects for the chess group, and this group scored significantly better than the control group.

It is not clear from these three studies whether students who are economically disadvantaged do worse than their 'not economically disadvantaged' counterparts. However, learning chess may well have advantages for economically disadvantaged students.

2.9.3.2 - Behavioural Problems 5-11 Year-olds

The study by Fried and Ginsburg (u.d.) involved grade 4/5 chess students who had been referred for counselling due to mild and persistent behaviour problems, and who received 18 chess lessons through the academic year. The researchers administered post-tests for spatial relations analysis and behaviour at the end of the study period.

The findings showed that the results were not statistically significant indicating no difference between the chess group and control group (also with mild and persistent behaviour problems) that did no chess. Research weaknesses include having no pre-test and a relatively small sample size. Further, no consideration was made for other variables.

2.9.3.3 - At Risk of Academic Failure Students/Learning Difficulties 5-11 Year-olds

In the study by Hong and Bart (2006), the chess group of 18 students (15 at risk) took 12 weekly chess lessons of 90 minutes each, whilst the control group of 20 students (17 at risk) did after school activities. The students were aged 8-12. There was no difference between the chess group and control group in pre and post TONI-3 tests for cognitive thinking, but chess skill rating was indicated as a key predictor for the improvement of cognitive skills of the students.

It is suggested that students at risk of academic failure would need more time studying chess for them to gain the perceived cognitive benefits. As is the case with all students, it is not clear from the research at what level of chess playing skill children receive the various perceived benefits of learning chess, if there are any. It seems unlikely that chess players who are complete beginners can receive significant benefits while they are simply learning the basics. It also seems likely that three months is too short a time for complete beginners to start gaining the perceived benefits.

The study identified that the maximum amount of practice for a student was 900 minutes and the minimum 270 minutes. The more students practise, the more likely they are to gain benefits in cognitive thinking. This is just the sort of information that can be teased out through mixed methods research. By interviewing a significant number of students late on in the duration of a study, much relevant information can be obtained, and then analysed at the micro level.

The very short study period and the relatively small number of students were weaknesses in this trial. Also, there was little allowance for or analysis of variables.

Scholz (2008) wanted to study what benefits, if any, accrue to third and fourth grade children with learning difficulties who received chess instruction in place of maths lessons (IQs ranged from 70-85). The study took place over one school year where

the chess group had chess lessons instead of maths. The control group continued to receive maths lessons.

Fifty-three students participated in pre- and post-tests for calculation abilities, 31 in the chess group and 22 in the control group. Because of an interruption due to a fire alert, only 20 in the chess group and 10 in the control group took the tests and these were eligible for comparison. The average age of the students was 10.0 years in both groups.

It was found that on tasks in written form, gap tasks, and concentration, the development of the chess and control groups was equal within the year of study. Hence, no evidence was found for a low road transfer of chess to these skills. However, the performance for sets, counting and simple calculation tests has been significantly improved in the chess group, even though the control group had more regular maths lessons.

The researchers concluded that chess could be a valuable learning aid for children with learning disabilities. Transfer of skills from chess lessons to an improvement of basic mathematics skills has been observed. Weaknesses in the study included the small number of students and no active control group. Also, some variables are not accounted for.

The statement ‘chess skill rating was indicated as a key predictor for the improvement of cognitive skills of the students’ from the Hong study, and ‘the performance for sets, counting and simple calculation tests has been significantly better improved in the chess group, even though the control group had more regular mathematics lessons’ from the Scholz study show some cause for optimism. There are all sorts of complications, and this researcher believes that much can be gained from a mixed methods approach, allowing for a careful consideration of many variables.

2.9.3.4 - Cognitive Development of 11-15 Year-olds

Frank (1974) and Christiaen (1976) appear to be amongst the first researchers to conduct studies in the field of chess and education.

In this 12 month study, Frank (1974) endeavoured to ascertain whether the ability to learn chess is a function of a) spatial aptitude, b) perceptive speed, c) reasoning, d) creativity, or e) general intelligence. He also wondered whether learning chess could influence the development of abilities in one or more of the five types specified above. A significant correlation was found between the ability to play chess well, and spatial, numerical, administrative-directional, and paperwork abilities. Other correlations obtained were all positive, but only those mentioned were significantly so.

This finding tends to show that an individual's ability in chess involves the presence of many aptitudes which all work together rather than only one or two abilities. The second hypothesis was confirmed that there was a positive influence on the development of both numerical and verbal aptitudes by learning chess. There was no randomisation in this study, no active control group and no consideration of variables.

In the 16 month study, Christiaen (1976) investigated the effect of chess instruction on children's cognitive development, and more specifically, on the appearance of the stages as described by Piaget's theory of cognitive development. The interest lay in the transition between the stages of 'concrete operational thought' and the next stage called the 'formal-operation' stage. Christiaen was particularly interested to see if a chess programme can accelerate this stage. Significant positive results were shown for the chess group versus the random group who received no instruction.

It is claimed that this trial was a good starter for investigating the longitudinal effects of chess instruction. Possible weaknesses in the trial were that there was no pre-test, a relatively small sample size, no active control group and no attention to variables.

These two studies provided a solid foundation for further research and have been widely cited.

The study by Horgan and David (1990) relates to one school of 700 students in Memphis, Tennessee with a chess club of 113 students (33 in years 1-3; 34 in 4-6; 24 in 7-9 and 22 in 10-12). They participated in local, regional and national competitions, and some in a week-long summer camp. The school had a high proportion of national level chess players. The researcher states that improvement in skill is related to experience, and chess players score higher than average on the Raven's Progressive Matrices. Also, scores on a chess-specific test, the Knight's Tour, correlate with scores on the Raven's.

The first two experiments replicated and extended that of Chase and Simon (1973). The third experiment, which asked the 59 players to judge similarities of chess positions, demonstrated that similarity judgements become more global and abstract with increased skill. Horgan queries whether one can speculate that learning chess at an early age will affect other kinds of cognitive functioning.

Horgan and David observed that children generally play faster than adults and states that this is because children do not generate a long list of candidate moves, they 'satisfice.' That is they generate moves until they find a satisfactory move, not necessarily the best, and cease generating alternatives. This can lead to errors but is quite effective in speed chess.

These researchers also observed that children who play in a chess club, where they just learn the moves and play friendly games against other novices, learn chess very slowly. Coaches do not wait for children to discover principles, they teach them. Opening systems are memorised and practised. Children enjoy memorising opening systems, learning their names, and classifying them. These book moves are not specific piece configurations. They are dynamic systems, with variations and underlying principles and strategies.

The chess groups in some studies just play chess in a chess club, without receiving any chess instruction. Accounting for the comments of Horgan and David, it is unlikely that these students would show much improvement in chess, or transfer of thinking skills. It is logical that children receiving chess instruction, as well as playing and practising chess, would be more likely to improve their chess, and increase the possibility of transferring thinking skills into other domains.

The ‘teacher effect’ or ‘coach effect’ has hardly been touched upon in the various research papers in the field and is one of several important variables that need to be studied to understand the acquisition of thinking skills of the children in the study.

Horgan and David state that chess offers unusual opportunities for ‘process feedback.' In tournament chess, players are required by the laws of the game to write down all their moves on a scoresheet. This then provides them with an opportunity to play the game through later, either with their opponent, their coach, their computer programme or just by themselves.

> ‘Learning to analyse one’s own performance objectively provides an excellent lesson on how to maximise skill. In chess, a player has little opportunity to rationalise losses; children learn to be objective about their own performance. In addition, their improvement is readily measured by increased ratings’.

The researcher can relate to this. It is at this stage of chess development when students start to record their games and go through them with their coach, that possibly enables them to gain maximum benefits in acquiring various thinking skills. A coach will often ask their student, ‘what were you thinking when you played this move?’ ‘What about this alternative idea?’ ‘Reasons’. Followed by discussion. This process will go on regularly between coach and student, until it becomes normal for the student to discuss their games with their opponent (immediately after their game) and later with their peers.

Chess coaches also use other techniques, such as requiring their students to practise chess problem-solving. This can involve a variety of themes and helps to improve their tactical thinking. They also get their students to play chess with a mixture of

time controls, involving more and less thinking times, to get them to both improve their time for careful analysis and to help them with their intuitive thinking skills. Introducing them to blindfold chess helps them with their visualisation and this, in turn, helps with flexible thinking.

After 20 hours of chess lessons conducted over one week, according to Celone (2001), a significant increase from pre-test to post-test results was found amongst the study group of 19 students aged 7-14 for both abstract reasoning and chess specific problem-solving ability. The researcher believes the study extends and confirms Christiaen's 1976 study about the students' abstract reasoning and problem-solving ability. It supports the idea that learning chess helps advance students' IQ scores.

The main criticism of this study is that there is a small sample size with students being self-selected, without randomised selection or having a control group. With such a short period between tests students may learn from the first and perform better in the second. Little allowance was made for variables.

In a 12-month study of 6-16 year-olds by Aciego et al (2012), it was found that, unlike the basketball and soccer players, the chess group improved their cognitive skills, coping, problem-solving skills and socio-affective development. The researchers believe that the study shows that chess is a valuable educational tool. 'After one year of practising chess, the students performed better in tests that required cognitive skills and resistance to distraction, perception, speed, planning, and foresight.'

Weaknesses identified in the study were the lack of randomisation, self-selection of the groups and little allowance made for several variables, including age and gender. The study by Kazemi et al (2012) involved 86 randomly selected males from fifth, eighth and ninth grades in the chess group who were taught chess for six months, and a randomly selected control group of 94. The chess group scored higher in the maths test and metacognitive questionnaire than the control group. Importantly, there was a strong positive correlation between the students' maths and metacognitive scores.

The researchers believe that learning chess can be used effectively for the development of higher order thinking skills. They also claim that chess would create a strong belief system in the individuals for solving problems. There was no pre-test conducted in this study. Variables such as gender, teacher effect, course, etc, were not considered. As is the case with several of the studies under review, the researcher commented ‘So, there is much room for interested researchers and scholars to do new similar studies with the hope that they may contribute to this field of study.'

The information for the study by Thompson (2013) was gathered from an Australian private boys’ school with a strong chess tradition. The school regularly enters teams in primary and secondary inter-school competitions. The students studied chess regularly with an experienced coach and participated in fortnightly inter-school team competitions. All students also participated in the Australian Schools Science Competition. The total number of students having available IQ data from grades 6-12 was 508, of whom 64 were competitive chess players. Thompson argues ‘the results of this study do not provide support for the hypothesis that the playing of chess leads to improved scholastic achievement.'

Thompson concluded that: ‘It is possible that the methodology of controlling for both grade level and IQ has removed the effect that has traditionally been attributed to chess, suggesting that those students who have been interested in chess have tended to be the most capable students. That is, the students who performed more ably at a particular grade level tended to have a higher IQ, and there did not seem to be any significant effect of the playing of chess’.

A qualitative study by Laws (2014) involved five high school students and about 10-20 contact hours with the researcher over a period of 3-4 weeks. The researcher wanted to explore abstract cognition amongst chess club members. The students were exposed to chess puzzles, blindfold chess, playing chess with the researcher, and vocalising thought processes. The five students studied included a low-achieving student, a high-achieving student, an economically advantaged student, an economically disadvantaged student and an at-risk student.

The Piagetian Formal operations stage framework (Piaget, 1971) was used to explore and investigate the meaning of abstract cognition. The findings concluded:

> 'This study produced data in support of the consensus among many postmodern chess players that chess is an abstract gateway to an increased cognitive capacity and ability. Further, the data suggest that scholastic chess is both an abstract strategy game and a mode of intellectual improvement conducive to increased life and scholastic success'.

The researcher found that blindfold chess was an excellent conduit to the study of abstract thinking as a phenomenon. Visual-spatial ability and discreet pattern recognition were two aspects of abstract cognition that were strongly evidenced during blindfold play. 'Learning chess may facilitate the manifestation and phenomenon of abstract cognition, and participation in scholastic chess may produce scholarly and critical thinking individuals.' The researcher concludes that 'chess affects the transition among Piaget's cognitive levels.'

The Laws study provides encouragement to pursue the possibility that learning chess could accelerate a child's progress through the cognitive levels of thinking.

The author of this thesis is also interested in the transition among Piaget's cognitive levels, particularly amongst primary students, and describes Piaget's theory later in this chapter.

2.9.3.5 - Cognitive Development 5-11 Year-olds

There are many aspects of chess and education covered in this literature review. Most interest has centred on the field of chess and cognitive thinking skills of primary age students. Researchers often link 'chess and maths', with 'chess and cognitive thinking skills'.

A very interesting study by Rifner (1992) examined whether thinking skills amongst grade six and seven middle school students could be transferred from the chess domain to that of poetic analysis. Students were selected randomly from chess and

non-chess groups. From grade six there were four chess boys and five control group, and from grade seven there were also four chess and five non-chess boys.

The chess players had a rating of between 650 and 1000 according to the United States Chess Federation ranking system. They were scheduled one hour of chess instruction weekly during school time for one school year.

Calculations were made of the effect size of measurements obtained, and these indicated that chess training was effective in improving the skills of the students. Rifner's study was important for the number of variables considered, the number of search methods used, the number of targets, the number of lines tested, the number of guesses made, the number of negative evaluations that were not resolved and the proportion of goals achieved. Pre- and post-tests were used for all variables.

The results of the quantitative descriptive study showed treatment effects for all students in the gifted group, but for average students, only the number of methods used. Rifner found that middle school students of gifted and average ability were able to apply problem-solving skills learned in one domain (chess) to another far domain (poetry) if the skills are taught by following methods described by various researchers, including Perkins and Salomon (1992).

According to Rifner, these processes involve detecting a problem, scanning the task environment for information relevant to the problem, defining the problem, searching for a solution, evaluating potential solutions, and implementing the solution judged to be best. To the researcher, these steps are completely logical.

Rifner's study importantly demonstrated that although difficult, it is possible for far transfer of thinking skills across domains to occur. This is relevant to the researcher who wishes to ascertain 'at what stage, if any, of a child's age or level of chess playing strength can the transfer of skills across domains happen?' The small number of students in the study by Rifner is a weakness in the methodology, and several variables of interest to this researcher were not considered. More work in this area is warranted.

The study of Gaudreau (1992) involved three groups of fifth graders totalling 437. The first group did the traditional maths course throughout the study, while the second group received traditional maths in grade one followed by a programme of chess and problem-solving. The third group received the chess enriched course from grade one onwards. There is a disparity in the length of the study which was said to be for three years, but the students started in grade one and finished in grade five. There were no significant differences revealed by the standardised test. However, both chess groups did better on problem-solving than the maths only group. Also, the group that did chess enrichment throughout did better in comprehension than the maths only group.

Liptrap's study (1998) involved 67 gifted and talented and academically able elementary students in the chess group having received chess instruction for an hour a week for two years. There were 504 in the control group who were non-chess players. By year five, there was a significant improvement in maths and reading scores for the chess group as against the control group. Regular (non-honours) elementary students showed twice the improvement of non-chess players in reading and mathematics between third and fifth grades. The groups were not randomly selected, and there was no active control group. Variables were not fully accounted for.

In a twelve-month Scottish study by Forrest et al (2005) involving grade 3 students, pre-tests and post-tests for reading, comprehension, spelling, maths and social adjustment were given. The chess group performed best at comprehension and maths, while the computer group did best at vocabulary and maths. However, the chess group did best of all at social adjustment. The results were not statistically significant suggesting there was no difference between the treatment and control students. Failure to control for differences in past achievement may have generated biased results. No account was made of other variances.

The study by Kramer and Fillip (u.d.) was conducted circa 2005/2006. The chess group involved 84 elementary school students, and the control group 83. The chess

group received one hour of chess a week, in place of a maths lesson. This was a field study with a focus on concentration, IQ, spelling and inclusion (for example those with mixed abilities and disabled students). The top year received one year of chess study, while the youngest received 3.5 to 4 years.

The chess group showed significant improvements in concentration and perception, most obvious amongst first and second year, and underachieving students. The increase in IQ in second-year students was regarded as significant, whereas there was no improvement in spelling by that stage. In year three and four students, the most notable improvements were in motivation and social competencies. It is not clear from the research paper whether there were pre-tests and post-tests, and there was no active control group. The paper acknowledged deficiencies in the consideration of variables.

In Sigirtmac's study (2012) the subjects were 50 six-year-old children (25 boys and 25 girls) who had been taught chess and 50 children (25 boys and 25 girls) who had not. The chess group was significantly better at understanding the concepts assessed in the test. It was found that chess instruction had a positive effect on the students' development of concepts.

The researcher believes that 'while the children are learning how to play chess, they hear about each of these and many other spatial concepts, learn them, and frequently use them while playing chess. There were no meaningful gender differences for any of the concepts These results show that learning spatial concepts through chess is an effective strategy during the early childhood period'. There was no pre-test for this study, and no active control group. There was no randomisation and little allowance for variables.

The 701 students involved in the study by Martinez (2012) constituted 220 in grade 3, 234 in grade 4 and 247 in grade 5. By year 2007/8 there were 252; 233 in 2008/9 and 216 in 2009/10. Those doing chess was 29, music 246, both 38 and neither 388. The chess group attended a club that met for 45 minutes once a week over nine

months during the school year. Data gathering consisted of surveys, teacher records, and official school reports. Martinez was aware of the need to account for variables.

While music and chess students on average outscored the 'neither' group, music and chess may be simply a facet of their overall cognitive ability and interests, apart from fourth-grade maths students where it was statistically apparent. The finding of a statistically significant difference in fourth-grade test scores favouring students who engage in instrumental music, chess, or both, suggests that an important pedagogical timeframe exists in fourth grade in which enriched students reap the academic benefits of learning music and chess and that these benefits are particular to fourth graders. Students having the most practice times and frequencies in music gained significantly higher scores in maths.

Interestingly, the researcher found that males outperformed girls in maths, and girls outperformed boys in reading and verbal skills. Possible evolutionary reasons were suggested by Joseph (2000). This was discussed later in this study under the heading Gender Issues in Chess.

Perhaps because the author had surveyed students' practice time outside the standard lessons, it would infer that this study was more reliable than others that did not study this variable. But the author indicated there were important differences between the musicians and chess players. Musicians were often involved in more than one ensemble and were constantly practising for upcoming performances. Also, they always learned in a group of five. In contrast, the chess students did not participate in any competitions. Their 45 minutes weekly class had approximately 30 students. Their chess lessons which included some teaching of chess ideas was largely on a social level.

The researcher believes that by performing a similar study with a larger chess group including measurements of several extraneous variables, accounting for practice times, together with some qualitative data, would provide a greater understanding of the reality of benefits or otherwise. Martinez' idea of using a music group as an

active control is appealing to the researcher, as similar claims have been made for the educational benefits of music, as with chess.

A key focus for this researcher is the need to play regular games of chess to synthesise ideas that have been learned. Ideally, these regular games are under tournament conditions. If the games are rated, it contributes to students' keenness to focus on results.

In the study by Sallon (2013) the chess group consisted of 201 grade 4 students who had chess instruction since grade 3, and a non-chess group of 282. The chess group showed better results than the control group in numeracy, spatial awareness, logical deduction, and problem-solving. The research methodology was basic, but the number of participants and the surveying of different schools deserves investigation. Little allowance for variances was made. The programme will be continued into years 5 and 6 to establish if there is an optimum time for children to learn chess, and also to investigate gender differences.

The study of Sala et al (2015) included 309 3rd, 4th and 5th grade students in the chess group (of whom 193 declared they could play chess before the study) and 251 in the control group (of whom 76 had chess experience before the study). The chess group received 10-15 hours of chess instruction, plus some online training, whilst the control group did normal classes.

Results show a strong correlation between chess and maths scores, and a higher improvement in maths in the chess group as compared to the control group. The researcher concluded that these results foster the hypothesis that even a short time of chess practice by children provide
a useful tool for enhancing their mathematical abilities. There was no active control group in this study. Some variables were not considered.

The study by Gliga et al (2014) involved 20 grade 3/4 beginner chess students who did 10 chess lessons over 10 weeks ending with a tournament, while the control group did 10 fun maths lessons instead. Most cognitive skills increased from pre-test

to post-test in both groups, but the School Performance Test (SPT) in maths and Romanian language increased significantly more in the chess group. Resistance to monotony and not their IQ level at pre-test predicted success in the chess groups' test.

The study found that although having a high IQ contributes to better performance in school, sustained attention (and possibly the amount of time spent in sustained training) is the most important ingredient in chess performance. Weakness found in the study was the short period of learning and small number of students involved. A second placebo control group would have been helpful. There does not appear to be any allowance for variances.

Fifty-two students mean age 9.32 years participated in another trial by Sala (2016). There were three groups: chess for 15 hours; the Chinese board game Go (placebo) 15 hours; regular lessons 15 hours (control). 'Go' is similar in some ways to chess. The researchers found that chess was more effective than Go at enhancing students' mathematical skills, but not than the 'do nothing' control group.

The study did not show any advantages with metacognitive skills. The three groups performed equally in this test, and the researcher suggests that metacognition is not a cognitive link between chess and maths skills. The relatively small number of students and low number of hours of instruction were weaknesses in this trial. Also, the motivational qualities of the teacher involved with each class could have been an issue. Some variables were not considered.

It is not easy to follow a trail between these eleven studies. There is a suggestion of modest positive benefits for thinking skills for children learning chess in most of them, but always with some qualification. None of these studies sufficiently considered possible variables involved.

Rifner looked at the transfer of skills, Gaudreau considered problem-solving and comprehension, Liptrap - reading and maths, Forrest - social adjustment, Kramer and Fillip - motivation and social competencies, Sigirtmac - cognitive thinking

development in early childhood and Martinez was concerned with results peculiar to fourth graders, as well as issues of gender and practice times. Sallon conducted a mega-study relating to various cognitive thinking scores, Sala considered practice time and maths, and Gliga looked at sustained attention and practice times. Sala conducted an additional study that suggested that metacognition is not a cognitive link between chess and maths skills.

These studies all contribute in various ways to knowledge in the field of chess and education for 5-11 year-olds. This researcher is convinced that conducting an appropriate study and collecting data with a wide range of variables, will contribute to new and useful knowledge, and bring greater meaning to the perceived benefits.

2.10 - How Children Think – Piaget's Theory of Stages in Cognitive Development

This researcher is interested in whether learning chess can positively influence the thinking skills of primary school students aged from five to eleven. This paper studies several different types of learning which relate to chess, contributing to their place in the theoretical context.

Several theorists have put forward amendments or advancements to Piaget's theory, but his framework of stages in cognitive development appear to this researcher to be the most appropriate for considering children's chess thinking. His theory deals comprehensively with how children acquire, construct and use knowledge.

Sensory-motor Stage (age 0-2) – Infants gain knowledge and understanding through physical interactions and experiences. Mobility provides more opportunities to develop intellectual abilities. Language abilities develop during the second year.

Pre-Operational Stage (age 2-7) – Behaviour is egocentric where children have difficulty in understanding the views of others. They show intelligence, and their

memory and imagination are developed, using symbols and mental images. Children use pre-causal thinking (animism, artificialism, and transductive reasoning), which is the way they think about 'cause and effect'. Animism is the belief that inanimate objects have lifelike qualities, artificialism is the belief that environmental characteristics can be attributed to humans, and transductive reasoning is when a child draws a conclusion from two separate, unrelated events.

Concrete Operational Stage (age 7-11) – Children commence solving concrete problems logically through trial and error. Abstract, hypothetical thinking is not yet present. This stage is characterised by seven types of conservation (number, length, liquid, mass, weight, area, volume). Children start to use inductive reasoning, which involves making inferences from observations to generalisations. During this stage, egocentrism is eliminated, and children can see things from the perspective of others, even if they think the perspective is wrong.

Formal Operations Stage (age 11-15) – Abstract thought emerges. Students consider outcomes and consequences of actions. Students develop metacognition, with the ability to monitor their thought processes. Students move on to solve problems logically and systematically, and go from inductive to deductive reasoning, where they can draw conclusions from abstract concepts using logic. This is an important stage which Piaget calls hypothetical-deductive reasoning.

Critics of Piaget's theory say that development of children's thinking does not always progress smoothly. Piaget himself acknowledged this. Also, younger children often can conduct complex reasoning well before the age denoted in Piaget's theory. Piaget did not account for how a child's performance can differ significantly across domains. Piaget showed that children go through the various stages of development and come to their own conclusions. However, this does not account for the social and cultural interactions of the child, which can vary considerably.

From his observations of junior chess players, the researcher believes that strong chess players aged from 7-11 often display most features of Piaget's formal operations stage. The opportunity to develop these skills is available in every game

of chess. A child's natural desire to win is a strong motivation to acquire and develop these features, even though in most cases the child would not realise this.

2.11 Gender Issues in Chess

In the chess community, there are often discussions about the disparity between the number of men and women playing chess, questioning why there are no women in the world's top 100 ranked players, and whether males are better than females at playing chess. These issues present good reasons why gender should be included as a variable in all chess studies.

Joseph (2000) - This paper studied possible evolutionary explanations for differences between the sexes.

Joseph observed that for 500,000 years, women carried out group and domestic activities, including child rearing. In contrast men were the hunter-gatherers and would often spend days or weeks travelling hundreds of miles from home in their hunt for food.

As a result, Joseph argues, women have 'clear language, articulation, word knowledge, syntax and related superiorities over males.' They 'vocalise more, engage in more social speech display superior linguistic skills and excel in word fluency tests'. Females speak their first words earlier, develop larger vocabularies at a younger age, their speech as children is easier to understand, they improve their articulation and grammatical skills at a faster rate, the length, and complexity of their sentences is greater, and they speak more rapidly.

By contrast, males display 'superior visual-spatial skills including superior maze learning, tracking, aiming, and related nonverbal abilities.'

Joseph concludes that males are superior in the

> ‘recall of geometric shapes, detecting figures that are hidden and embedded within a complex array, constructing three-dimensional figures from two-dimensional patterns, visually rotating and detecting the number of objects in a three-dimensional array, and playing and winning at chess (which requires superior spatial abilities)’.

While females have an advantage in sequencing language, males are better at sequencing space. Therefore, males are more likely than women to be mathematical geniuses.

Boyle et al (2010) - studied ‘sex differences in cognitive task performance that emerged when 39 Australian university undergraduates (19 men; 20 women) were asked to solve verbal (lexical) and visual-spatial cognitive matching tasks which varied in difficulty and visual field of presentation. Sex significantly interacted with task type, task difficulty, laterality, and changes in performance across trials’.

The results, which have significance for studies in the field of chess and education, showed that the ‘significant individual differences’ variable of sex does not always emerge as a main effect, but instead showed significant interactions with other variables which were manipulated experimentally. 'Importantly it argued that ‘sex differences must be taken into account when conducting experiments into human cognitive task performance.'

2.12 Summary, Analysis, Discussion and Ideas for Research Project

There are many different types of thinking. On reflection, after a long involvement in chess, the researcher concludes that learning and playing chess automatically and abstractly results in the player utilising different thinking skills. The longer the time spent learning and playing chess, the greater the number of thinking skills used.

An analysis of the various readings shows that the transfer of thinking skills from one domain to another is, at best, difficult. Many of the studies relating to chess and

maths, and chess and thinking skills, show some benefits, although not all do, and importantly the researchers are tentative in their findings. With the many active and attribute variables involved, it is difficult to believe that significant findings can be achieved with only quantitative or only qualitative research methodology. Mixed methods, the researcher believes, are required to gain meaning and understanding of the many variables.

It is said by various researchers that children learn best while having fun. Gray (2013) -describes four 'conclusions', listed below, which he says are supported by numerous experiments, and which when, taken as a whole, show that learning, creativity and problem-solving are worsened by activities that reduce playfulness, and improved by activities that promote it. There are:

- Pressure to perform well interferes with new learning
- Pressure to be creative interferes with creativity
- Inducing a playful mood improves creativity and insightful problem solving
- A playful state of mind enables young children to solve logic problems

There is an argument that all schools would benefit from including chess, either in their curriculum, or as an extra-curricular offering, to exercise students' various thinking skills in a regular fun lesson. The argument would be enhanced if there is shown to be a correlation between learning to play chess and improvements in thinking skills.

Schools provide many opportunities for students apart from academic studies; for example, sport, dance, speech and drama, music and outdoor education. Chess would fit in neatly for many students who have little interest in these activities. This may provide these students with an interest where they could receive recognition and enhance their self-esteem to help them through what can be difficult high school years. However, chess can also appeal to students who excel at, or are very interested in, several other school activities.

When reviewing chess studies on chess and education, no papers relating to chess and critical thinking were found that focus on primary school students and only two that mentioned chess and creative thinking. The Amelkina (2009) and Sigirtmac (2016) studies were promising. No papers were found that looked at primary school chess students and strategic thinking.

One important factor not addressed in the papers reviewed is the need for children who have chess lessons to play regular games of chess elsewhere. The researcher has witnessed many students who, despite having regular chess lessons, do not play regularly, and show no improvement. Parents are told that it is good to learn chess, but to retain and synthesise ideas, it is necessary to play chess regularly.

Many ideas and themes are taught to chess students, and they need time to practise and synthesise all the information before it translates into playing strength. Competition chess is the best because it gives extra incentive for the students to focus on the task. Most students who learn and play chess with enthusiasm improve fast. The intensity with which they learn and play seems to be the key to improvement.

Mixed methods research which includes quantitative data from testing and qualitative interviews can reveal substantial information. For example, the following questions can be asked of students towards the end of a study:

> Have you played in any tournaments involving adults and clocks this year?
> Have you played regular chess at home with your family this year?
> Are you a member of an out of school chess club?
> Have you represented your school in an inter-school competition this year?
> Have you used a chess clock?
> Do you know how to keep score in a game of chess?
> Do you enjoy your regular chess lessons, or are they boring?
> Do you have a chess rating?
> When did you first learn chess?

Do you do any extra chess at school each week (eg., lunchtime chess club, casual chess games in the library)
Do you have extra coaching each week at your home from a private coach?
Is your regular chess lesson the only chess you do each week?

Answers to these questions can be scaled, to give quantitative results, and within the questionnaire comments can be invited to contribute to qualitative results.

Questions such as these, along with others for parents and teachers, can help to give real meaning as to how, and at what age or playing strength, each child might gain a transfer of skills between domains.

There is a common theme running through all the chess and cognitive thinking papers examined here. There are so many variables to consider that the researcher is unable to discern any strong findings. These variables include age, gender, year level, IQ, chess ability, the chess course being taught (or a chess club if without teaching), the teacher effect, classroom presentation, prior chess experience, motivation, extra chess (eg, chess at home, lunchtime club, out-of-school club). Confounding variables usually not considered include whether the child has extra non-chess home tuition or attends extra non-chess classes at an after-school or with a weekend tuition company. Sometimes the chess programme is additional to or replaces the academic programme.

Questions to be addressed in future studies include the following: Do all students gain benefits at some stage, or only the academically able students, or those keen to get or improve a rating, or motivated to improve their rating? Are ratings an influence because of perceived educational benefits? Do students who enjoy chess lessons but aren't interested in competitive chess gain benefits? Do those students who only attend chess because of parent pressure gain benefits?

A Masters study was proposed that would involve four groups of children who participate in chess, music, both and neither from February to November. The study would take place in one school, with modest research aims, but with the over-riding

aim of being a testbed for seamlessly moving into a doctoral longitudinal study. Attention would be paid to measuring variables that could affect the results, especially those that indicated extra chess was undertaken by participants.

The research question proposed was:

> *Does learning chess affect cognitive thinking scores of Australian grade 1-5 chess students, and what variables, if any, affect the results?*

It is unlikely that a quantitative or qualitative study conducted separately could gain the real meaning required from this study.

Kumar (2014) believes that action research comprises researching the aspects of concern, analysing data regarding these aspects, suggesting changes and taking action to make changes where required. He believes that action research follows two traditions. He states that the British tradition means the 'improvement and advancement of practice', whereas the American tradition means the 'systematic collection of data that provides the basis for social change'.

Ivankova (2015) supports the idea that action research comprises identifying the problem, collecting, analysing and interpreting data, developing a plan for action, implementing the action plan, collecting, analysing and interpreting the data collected and revising and testing the action plan. The writer believes that it is necessary to use systematic research procedures to produce credible knowledge that can be replicated elsewhere. She also states that action needs to be flexible, where researchers go back and forward reflecting upon the 'problem, data collection, interpretation and action'. It also needs to be cyclical and is a 'continual improvement process'.

Ivankova reports that traditional action research has been used by classroom teachers to conduct a disciplined inquiry with the aim of 'informing and changing their classroom practices.'

Mixed methods research, with a convergent design was chosen as most appropriate for this study. Pragmatism is a fundamental philosophy of researchers using mixed methods. They like to use both quantitative and qualitative methods in multistage research. The research question is considered more important than the method or paradigm used. Pragmatists reject the ‘either-or’ view relating to quantitative and qualitative research and embrace both. Pragmatists relate to a practical and applied research philosophy. Ivankova (2015) (quoting Tashakkori and Teddlie).

Kumar describes the convergent parallel design using pragmatism as an umbrella philosophy, which places equal emphasis on quantitative and qualitative data, implements both at the same stage of the project, keeps the two strands separate during analysis, and then mixes the results during the overall interpretation. This method allows a more complete, in-depth understanding of a study, and can be used to corroborate or validate the quantitative findings. Kumar states that common variants are the use of parallel databases, data transformation and data validation.

This method is appropriate for addressing the research question. Attribute variables such as age, year level and gender, can be defined in databases. Extraneous variables such as teacher effect, teacher motivation, chess course, regularity of chess play, evidence of tournament play, evidence of rating, evidence of an out of school club, motivation of the child, and use of computer chess programmes can be gathered through interviews or surveys.

The researcher considers that this method enables all students to be measured quantitatively, in before and after tests for cognitive thinking. It also enables many short interviews to be conducted with student participants, teacher chess coordinators and the parents of students involved. This is a logical method to understand and to interpret the quantitative results.

The methodology aims to overcome some of the weakness as found in the studies examined. An inability to interpret results adequately is due to the lack of data from several extraneous variables. In some studies even the attribute variables were not considered.

Somerset College (primary school only) located on Queensland's Gold Coast was chosen as the school to be used for the study. It was not considered practical to have several schools involved for this Masters research.

The target school is one of very few schools in South East Queensland where over 100 students are taught chess every week using a standard chess course during school time.

There are three or four different chess coaches teaching these chess students at primary level. Many of these students additionally represent the school in inter-school chess competitions and many also attend an optional lunchtime club, which is free and is open every school day. Some students play regular chess at home, some play regular chess online and some play weekend chess tournaments, many of which involve adults. Some students do additional weekly private chess lessons at home. Some attend the weekly lessons without any extra chess, while some only do chess lessons at their parents' insistence.

Ideally, all students in the primary school who are not part of the chess group, would form the control group, with music students tagged as such to provide an active control group. In this situation students doing chess and music would be tagged as such. All other students would form the 'do nothing' group.

The application for ethical approvals would ideally involve Somerset College providing all parents in the primary school with full details of the study, the ethical commitments of the researcher via USQ, and the option for them to opt out, or pull out at any stage. Parents of students identified as ADHD or autistic would need to be contacted separately for approval.

It was not considered practical to randomise the choice of participants for this study.

Chapter 3 – Methodology

Overall a post-positivist, quantitative, 2 phased sequential design, each involving a survey, was used. The initial survey involved a questionnaire where quantitative answers were obtained using the Likert scale, as well as qualitative comments for each question. These quantitative and qualitative results were then examined using a side by side analysis. The main study involved obtaining quantitative before and after test results, and a survey where answers were converted quantitatively. Results obtained were analysed using SPSS Statistics.

3.1 The Initial Survey

Approval for this research project was provided by USQ Research Ethics Committee – approval number H16REA011.

The pragmatic paradigm was the approach used for the initial survey. Pragmatism is problem-centric and researchers collect data in the most practical available manner to address the research question. Researchers can test multiple hypotheses, provide biased and unbiased perspectives, collect and mix quantitative and qualitative data, and write in a formal or informal style. Pragmatism recognises the importance of the empirical breadth that can be achieved by employing quantitative data methods with discovering greater depth of meaning using qualitative methods. Creswell and Clark (2017)

By using mixed methods, the pragmatic paradigm enabled the practicality of an online survey and the use of multiple perspectives. An online survey was designed to collect quantitative and qualitative data. The two data sets were analysed separately, and then the findings were assimilated with a side by side analysis.

The use of mixed method, convergent parallel design, enabled the collection of different (quantitative and qualitative) but complementary data on the same topic (aspects of chess thinking skills and other relevant questions). Collecting quantitative and qualitative data concurrently, enabled the triangulation of quantitative and

qualitative data in parallel to understand the meaning of the data collected. Triangulating and synthesising the information this way proves to be most useful in revealing the meaning behind answers Creswell and Clark (2017).

An online survey of stakeholders was administered in February 2016. Participation was voluntary. The sample included the school principals of 24 schools who did not offer chess coaching services to students. For sampling, stakeholders were defined as school principals, deputies, teachers, teacher chess coordinators, parent chess coordinators, parents, school students, chess coaches and 'other'. The survey was not specifically offered to students, but a few parents of children learning chess got their child to complete the survey. The survey consisted of 34 research questions based upon the Likert scale accompanied by a comments section, plus four descriptive questions also with a comments section, and one open-ended comments section.

Links to the survey were made available through the Gardiner Chess webpage and Facebook page. An invitation to participate was also emailed to the Gardiner Chess databases of school teacher chess coordinators, and customers (mainly parents of students who learn chess with Gardiner Chess). The link was also emailed to a database of school principals. The survey was closed at the end of February having received 315 responses that included 834 comments. The sample illustrated a good spread across all stakeholders.

The 834 comments included 97 open-ended comments. These were coded manually (more than once in cases where the comment referred to two or more different questions) and then added to the other comments for each survey question, together with a miscellaneous list that did not refer to any of the questions. Five stakeholders' comments were selected based on emerging themes from the content analysis against each of the 34 survey questions with the aim of reflecting the overall meanings garnered from it. The number of five comments from each survey question was chosen by the researcher after observing from his analysis that this was sufficient to gain the meaning required, and concise for the side by side analysis. These comments were then compared in parallel with the quantitative results for analysis.

A summary of all survey results is given in Table 2 on page 115, followed by tables of selected results of ten of the questions.

3.2 The Main Study

Approval for this research project was provided by USQ Research Ethics Committee – approval number H17REA021.

For the main study a postpositive, quantitative design was used. Postpositivism ‘challenges the traditional notion of the absolute truth of knowledge and recognises that we cannot be "positive" about our claims of knowledge when studying the behaviour and actions of humans.’ Also ‘developing numeric measures of observations and studying the behaviour of individuals become paramount for a postpositivist’ (Creswell and Clark, 2011).

Postpositivism often involves a quantitative approach. ‘Researchers make claims for knowledge based upon cause and effect thinking; narrowing and focusing on select variables to interrelate; detailed observations and measures of variables; testing of theories that are continually refined’ Slife and Williams (1995)

The research design for the main study in summary was as follows:

> Students opted-in to the study (with parent permission)
> Students were allocated to one of four study groups chess, music, both and neither
> The school provided before and after test scores for cognitive thinking skills for all students in the study plus their attribute variables such as year level, gender and date of birth
> The researcher obtained the QJRL (Queensland Junior Ratings List) ratings of chess students where applicable
> The researcher organised a 22-question survey just for students learning chess, and converted this information to data
> All data was uploaded to SPSS, cleaned, screened and analysed

The research project was approved by Somerset College and the school kindly emailed the parents of all 453 grade 1-5 students with details of the research, and the opportunity to opt-in. The school provided the researcher with the name, year level, gender and details of whether each child did regular co-curricular lessons for chess, music, both or neither. Also the name of the chess coach who taught each child. The researcher checked the QJRL and included the 'before' and 'after' chess ratings for students where applicable. The QJRL is produced to rate the playing strength of each student compared with all other students on the list.

'Before' and 'After' test scores for cognitive thinking skills were administered by school staff for all students and provided to the researcher. The time between tests varied between 6 and 8 months for the various year levels.

Grade 1 and 2 students were tested using Ravens Progressive Matrices (RPM) which are multiple choice intelligence tests of abstract reasoning. In each test item, the subject is asked to identify the missing item that completes a pattern. Many patterns are presented in the form of a 4x4, 3x3, or 2x2 matrix, giving the test its name. The grade one test comprised 36 questions, whilst the grade 2 test comprised 60 questions.

The Bilker et al study (2012) reports reliability of the Ravens instrument as follows: Original 60 item Ravens Cronbach Alpha r = 0.84; Arthur and Day (1994) 12 item short form Cronbach Alpha r = 0.72. Wytek et al (1984) 30 item single split-half reliability coefficient r = 0.95

Grade 3, 4 and 5 students were tested using *ACER* (Australian Council of Educational Research) *General Ability Tests* (*AGAT*) which helps teachers assess students' general reasoning ability. AGAT is claimed, by ACER, to be a thoroughly researched and nationally normed assessment instrument. However, no independent study could be found to confirm ACER's claim. ACER was contacted directly, but they could not help, for example, by pointing to independent research. Each of nine tests (approximately grades 2-10) assess students' reasoning skills in three areas:

verbal, numerical and abstract (visual). In the first level there are three tests of 10 questions each, and in the other eight levels there are three tests of 15 questions each. All students in the grade 3-5 cohort completed AGAT tests of 45 questions.

Key features of each test:

- Provide a multifaceted estimate of students' general intellectual ability and aptitude;
- Can be administered individually or to a large group;
- A common scale for all nine tests gives teachers the flexibility to match test level to ability and monitor development over time;
- Includes percentiles and stanines that allow for comparison with a national norm group at different year levels;
- Provides scores for different strands (Verbal, Numerical and Abstract reasoning) to help identify specific strengths and development needs.

Source ACER

Both RPM and AGAT tests are widely used in schools around Australia.

A 22-question survey was prepared, to find out if students had regular private chess lessons, attended out of school club, played inter-school chess competitions, had a Queensland Junior Chess Rating, and other factors considered relevant.

The survey questions aimed mainly to measure extra chess played by the students in addition to their regular weekly lessons, as well as such matters as regularity, enjoyment, coach effect, parent effect and confounding factors such as whether the child received non-chess home tuition or attended a tuition company such as North Shore etc. The students also gave optional answers to the question 'is there anything else you would like to say regarding your involvement in learning to play chess'. 45 comments are shown in Appendix 1.

3.2.1 Descriptive Statistics

The researcher prepared a codebook to enable the non-numeric survey data to be changed to numeric data before analysis.

This survey data was included in an Excel file along with the attribute variables, QJRL ratings scores, name of chess coach and before and after test scores for cognitive thinking skills for each student. This was then uploaded to SPSS.

3.2.2 Cleaning and Screening

- The process outlined by Hair et al (2006) for preparing data for analysis was followed.

- The data was cleaned and screened. The 'transform missing values' function in SPSS statistics was used to identify missing values. The 'before' or 'after' test scores for 22 of 203 students were missing due to absence. These missing scores were replaced using the series mean for the relevant year level, an acceptable missing data technique.

- The pplots were inspected for normality. All data was normally distributed, fairly evenly, close to the mean. Frequencies were tested for Kurtosis and Skewness using SPSS statistics. The results for 'TEACHER' relating to whether the student enjoyed their weekly chess lesson were removed, as the Kurtosis reading was outside the scale of normality (p82, Hair et al). This question was not regarded by the researcher as critical to research outcomes.

3.2.3 - Data Analysis

Once all data was ready in SPSS for analysis, the before and after test scores were converted to percentages, and then eight SPSS files were made for each of grades 1-5, Ravens Grade 1-2, AGAT grades 3-5 and one for all 203 students involved in the study. Manovas were created for all these eight groups analysing the four study

groups against test scores. Anovas were created for the chess group analysing all variables against test scores.

Chapter 4 - Results and Discussion – The Initial Survey of Stakeholders

4.1 - Bias

Readers of this discussion should be aware that the researcher has been involved in teaching chess to children for 25 years. This provides him with useful insights to draw from when analysing the results. On the other hand, it means that inherent bias may be present in the analysis. Also, Gardiner Chess, and other Australian companies providing similar services, carry information on their websites regarding various research studies that have been conducted over the years. Many respondents will have read this information and perhaps have been influenced by it when completing the questions in the survey. Consideration was given to this to mitigate the potential bias inherent in the study, by wording questions thoughtfully.

Before implementing the survey of stakeholders the researcher drew on years of experience in the field of chess and education, conducted a small literature review of previous research in the field, and constructed the survey to avoid bias or to lead the respondents. It was then trialled on a small group of colleagues in the field, as well as the study group, and feedback was obtained. Minor changes were made in the order of questions, and two new questions were added as a result. The researcher strived to correctly define the stakeholders, and to reach as many as possible.

By obtaining quantitative and qualitative data concurrently, the researcher was able to obtain a deeper meaning from the answers, thus reducing the risk of biased results. Finally, the researcher spent some time reflecting upon the whole process, with the aim of identifying some areas where bias may have occurred. For example, it was apparent that there was a stronger representation of state school principals over private school principals than would have been expected. Also, whilst there was a strong representation of parents of students learning chess, there were very few parents of students who were not learning chess.

4.2 - Quantitative Data Analysis

Table 1: Initial Survey of Stakeholders - Demographics

Responders	Total	State	Anglican	Catholic	Private Non-Denom	Other Schools	No Ans		Schools with a Programme	Schools without a programme	No Ans
School Principal in Schools with Chess Coaching	28	21	4	2	0	1	0		28	0	0
School Principal in Schools with no Chess Coaching	24	24	0	0	0	0	0		0	24	0
Deputy Principal	18	14	1	0	3	0	0		13	5	0
Teacher Chess Coordinator	52	33	2	8	3	4	2		35	17	0
Parent Chess Coordinator	6	4	0	2	0	0	0		6	0	0
Teacher not involved with Chess	12	6	0	2	4	0	0		6	5	1
Parent of Student who receives Chess Coaching at School	109	63	12	27	6	1	0		104	5	0
School Student who Receives Regular Chess Coaching at School	4	2	0	1	1	0	0		2	2	0
Gardiner Chess Coach	19	7	1	2	2	5	2		15	1	3
Gardiner Chess Non-Coaching Staff	4	0	0	0	0	4	0		2	1	1
Total	**276**	**174**	**20**	**44**	**19**	**15**	**4**		**211**	**60**	**5**
Total - Survey Monkey	**301**	**191**	**22**	**48**	**20**	**22**			**225**	**76**	

Note: The total number of responses was 316. Some respondents didn't respond to several questions

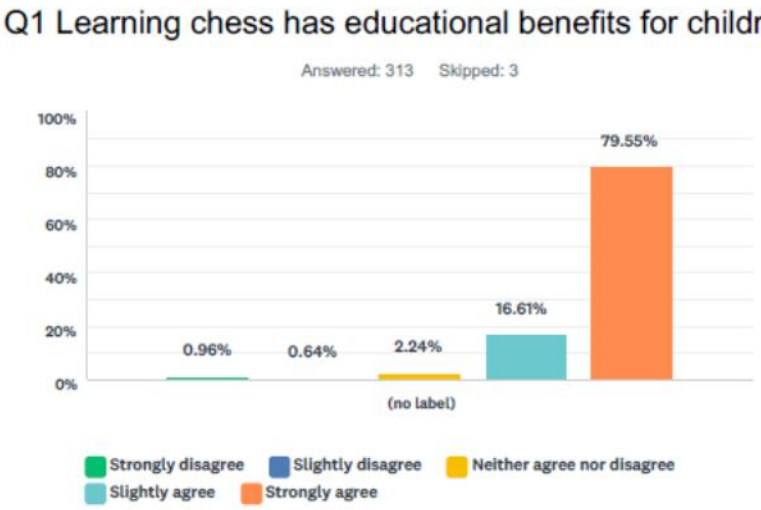
The summary of quantitative results for the survey of stakeholders is given in Table 2. The results for the question 'does learning chess have educational benefits for children' are shown in Table 3 and represented in Figure 1. Interpretations for Tables 3-11 in this section are taken from the side by side analysis of results shown in Table 12.

All the questions relating to the benefits for children in learning chess (Q1-Q22 and Q27) showed a predominant Pearson Correlation at .01, with some at .05. Table 2 shows that these questions had a weighted average response of between 3.8 and 4.8/5.

Question 1 (Learning to play chess has educational benefits for children) shows that nearly all respondents to the survey believe that chess does have educational benefits for children (Figure 2). On the other hand, Q25 (Learning to play chess is expensive)

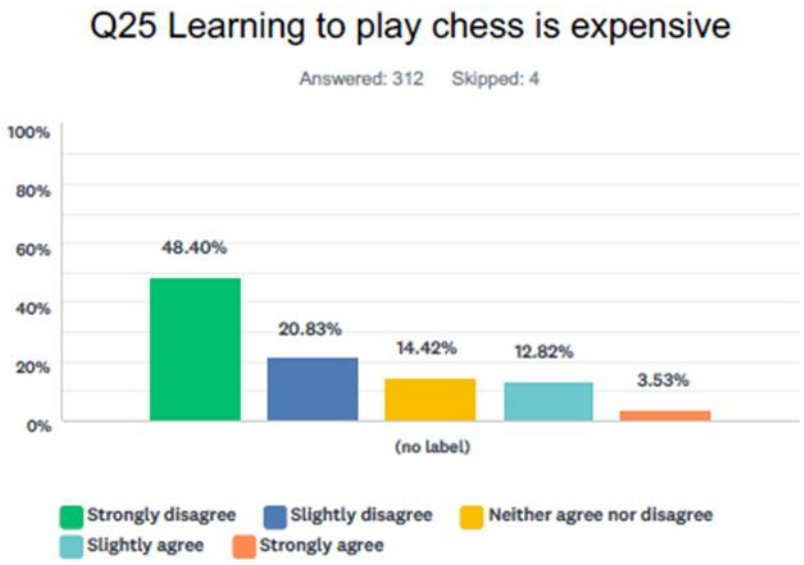
shows that respondents were not fully in agreement, with 17 per cent thinking it expensive (Figure 3).

Figure 2



	STRONGLY DISAGREE	SLIGHTLY DISAGREE	NEITHER AGREE NOR DISAGREE	SLIGHTLY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
(no label)	0.96% 3	0.64% 2	2.24% 7	16.61% 52	79.55% 249	313	4.73

Figure 3



	STRONGLY DISAGREE	SLIGHTLY DISAGREE	NEITHER AGREE NOR DISAGREE	SLIGHTLY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
(no label)	48.40% 151	20.83% 65	14.42% 45	12.82% 40	3.53% 11	312	2.02

Table 2: Survey Results Summary

Survey Question	Q No.	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
Learning Chess has Educational Benefits for Children	Q1	313	3	2	7	52	249	4.73	39
Learning Chess has Benefits for Indigenous and Torres Strait Islander Children	Q2	314	3	1	72	54	184	4.32	42
Learning Chess has Benefits for Children with various forms of Autism	Q3	313	2	1	86	57	167	4.23	52
Learning Chess has Benefits for Socially Disadvantaged Children	Q4	311	2	3	44	66	196	4.45	30
Learning Chess can have Benefits for Children with Behavioural Problems	Q5	313	2	2	66	79	164	4.28	36
Learning Chess has Benefits for Children with Learning Difficulties	Q6	309	1	4	84	79	141	4.15	31
Learning Chess helps Children Enhance their Numeracy Levels	Q7	311	1	4	45	110	151	4.31	25
Learning Chess helps Children Enhance their Literacy Levels	Q8	312	3	18	98	117	76	3.79	22
Learning Chess helps Children Develop Problem Solving Abilities	Q9	310	2	1	1	37	269	4.84	12
Learning Chess helps Children Develop Critical Thinking Abilities	Q10	312	2	1	1	44	264	4.82	9
Learning Chess helps Children Develop Creative Thinking Abilities	Q11	312	1	4	14	90	203	4.57	11
Learning Chess helps Children Develop Logical Thinking Abilities	Q12	312	2	1	3	38	268	4.82	10
Learning to play Chess Develops Children's Imagination	Q13	305	2	6	59	124	114	4.12	0
Learning to play Chess Develops children's ability to Innovate	Q14	311	2	7	34	117	151	4.31	12
Learning Chess helps Children improve their IQ Scores	Q15	312	9	4	123	79	97	3.8	31
Learning Chess helps Children with Concentration	Q16	313	2	2	5	67	237	4.71	10
Learning Chess helps Children to become Independent Thinkers	Q17	314	1	1	24	88	200	4.54	5
Boys and Girls Benefit Equally from Learning Chess	Q18	315	4	4	20	39	248	4.66	18
Learning Chess Teaches Children that they are Responsible for their own Actions	Q19	311	2	8	48	105	148	4.25	8
Learning Chess Teaches Children to Win and Lose with Dignity	Q20	315	3	9	25	90	188	4.43	27
Learning Chess helps Children Develop Life Skills	Q21	312	2	9	67	110	124	4.11	14
Learning Chess helps Children Practise Patience	Q22	313	3	3	10	83	214	4.6	8
Learning Chess is just for 'Nerds'	Q23	312	253	26	13	10	10	1.39	17
Learning Chess does not help Children Build Self Esteem	Q24	313	175	84	40	8	6	1.68	15
Learning to Play Chess is Expensive	Q25	312	151	65	45	40	11	2.02	28
Chess should be a Fully Funded Activity offered by all Schools	Q26	315	16	18	77	92	112	3.84	29
Learning Chess helps Children understand the Importance of Planning	Q27	314	2	2	11	102	197	4.56	6
Many Children do not have Fun whilst Learning Chess	Q28	314	120	91	67	30	6	2.08	29
Chess has a Good Reputation in the Community	Q29	314	6	31	47	125	105	3.93	19
Chess is a Sport	Q30	313	36	37	70	76	94	3.5	35
Special Needs or Academically-Inclined Children play Chess	Q31	313	20	17	139	80	57	3.44	33
Children who play Popular Sports are Less Inclined to Play Chess	Q32	314	54	57	86	100	17	2.9	31
The Cost of providing Chess Lessons at School is Reasonable (Average Charges range between $89 and $99 per Term, Per Student for a 1 Hour Lesson each week)	Q33	311	29	33	77	92	80	3.52	43
Costs of Inter-School Chess Tournaments are Reasonable (Average Charge is $19 Per Student to participate in a one-day inter-school Tournament)	Q34	314	13	26	62	112	101	3.83	0
Additional Open-Ended Comments									97
Total Comments									**834**

Detailed descriptive results of the main research question, (Learning Chess has Educational Benefits for Children), can be found in Table 3. All the descriptives in this table gave a weighted average response to this question between 4.5 and 5/5.

Table 3: Learning Chess has Educational Benefits for Children

Q1 Learning Chess has Educational Benefits for Children	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	0	0	1	5	22	4.75	1
School Principal in a school with no coaching programme	24	0	1	3	3	17	4.5	1
Deputy Principal	18	0	0	0	6	12	4.67	4
Teacher Chess Coordinator (in charge of chess)	52	2	0	0	5	45	4.75	9
Parent Chess Coordinator (in charge of chess)	6	0	0	1	1	4	4.5	1
Teacher (not involved in chess)	11	0	0	0	2	9	4.82	2
Parent of student who receives weekly group chess coaching at school	109	1	0	1	19	88	4.77	7
School student who receives weekly group chess coaching at school (age required)	4	0	0	0	0	4	5	1
Gardiner Chess coach	19	0	0	0	2	17	4.89	7
Gardiner Chess non-coaching staff	4	0	0	0	0	4	5	0
Total	**275**	**3**	**1**	**6**	**43**	**222**		**33**
Respondent's School has a chess programme	223	3	0	4	33	183	4.76	28
Respondent's School does not have a chess programme	75	0	1	3	12	59	4.72	9
Total	**298**	**3**	**1**	**7**	**45**	**242**		**37**
State School	190	0	1	6	34	149	4.74	20
Anglican	22	1	0	0	1	20	4.77	1
Catholic	48	2	0	0	7	39	4.69	8
Private Non-Denominational	19	0	0	1	4	14	4.68	3
Other	21	0	0	0	2	19	4.9	7
Total	**300**	**3**	**1**	**7**	**48**	**241**		**39**

Some other questions were not so clear, particularly questions Q25, Q33 and Q34. Tables 4 to 11 examine descriptive responses to these questions.

The substantial volume of comments in respect of virtually every question not only helped substantiate the quantitative results but provided rich insights to explain them. These are described in section 4.3 Qualitative Data Analysis, and in the side by side analyses in Table 12.

Questions Q25, Q33 and Q34, referring to the cost of learning or playing chess, proved to be the most contentious. Whilst there was a general view that the cost of learning or playing chess is reasonable, there were many comments relating to the problems for schools and individuals in low socio-economic areas. These results indicate that there is a need to provide affordable chess coaching services to these students.

Table 4 provides a descriptive analysis of the answers to Q25 (Learning to Play Chess is Expensive). Most groups believe that learning to play chess is not expensive. However, the highest incidence of those who do think chess is expensive is from those associated with catholic and state schools, traditionally known for servicing low socio-economic areas.

Table 5 provides a descriptive analysis of the answers to Q33 (The Cost of Providing Chess Lessons at School is Reasonable). Interestingly school principals disagree with this proposition by a margin of 22 to 17. Teacher chess coordinators agree with the statement by a margin of 21 to 14, whilst parents of students who receive weekly chess coaching also agree by the strong margin of 82 to 9. An analysis of the responses of school principals shows that of those in a school with a current chess programme, 10 slightly or strongly disagreed with the proposition, 10 slightly or strongly agreed, and seven had no opinion, whilst of those without a current programme 12 slightly or strongly disagreed, seven slightly or strongly agreed and five had no opinion. Of those with a current programme, 20 were from state schools, four from Anglican schools, two from catholic and one other. Of those with no programme, all 24 were from state schools.

Table 4: Learning to Play Chess is Expensive								
Q25 Learning to Play Chess is Expensive	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	14	6	5	2	1	1.93	0
School Principal in a school with no coaching programme	24	12	5	7	0	0	1.79	0
Deputy Principal	18	9	4	3	2	0	1.89	3
Teacher Chess Coordinator (in charge of chess)	52	33	7	6	3	3	1.77	4
Parent Chess Coordinator (in charge of chess)	6	2	0	2	1	1	2.83	1
Teacher (not involved in chess)	12	6	4	0	2	0	1.83	1
Parent of student who receives weekly group chess coaching at school	108	42	25	13	24	4	2.29	8
School student who receives weekly group chess coaching at school (age required)	4	3	0	0	1	0	1.75	1
Gardiner Chess coach	18	7	7	3	1	0	1.89	6
Gardiner Chess non-coaching staff	4	4	0	0	0	0	1	0
Total	**274**	**132**	**58**	**39**	**36**	**9**	**2.02**	**24**
Respondent's School has a chess programme	223	97	47	33	35	11	2.17	18
Respondent's School does not have a chess programme	74	42	15	12	5	0	1.73	9
Total	**297**	**139**	**62**	**45**	**40**	**11**	**2.06**	**27**
State School	189	88	41	33	24	3	2.01	14
Anglican	21	12	4	2	2	1	1.86	2
Catholic	48	18	11	6	10	3	2.35	6
Private Non-Denominational	20	8	4	1	4	3	2.5	2
Other	21	15	2	3	0	1	1.57	3
Total	**299**	**141**	**62**	**45**	**40**	**11**	**2.06**	**27**

Table 5: The Cost of Providing Chess Lessons at School is Reasonable								
Q33 The cost of providing chess lessons at school is reasonable (Average charges range between $89 and $99 per term, per student for a one hour group lesson each week)	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	27	6	4	7	7	3	2.89	7
School Principal in a school with no coaching programme	24	8	4	5	2	5	2.67	2
Deputy Principal	17	0	2	8	4	3	3.47	4
Teacher Chess Coordinator (in charge of chess)	52	10	4	17	14	7	3.08	11
Parent Chess Coordinator (in charge of chess)	6	1	1	1	1	2	3.33	1
Teacher (not involved in chess)	12	2	2	2	4	2	3.17	3
Parent of student who receives weekly group chess coaching at school	108	0	9	17	45	37	4.02	6
School student who receives weekly group chess coaching at school (age required)	4	0	1	3	0	0	2.75	1
Gardiner Chess coach	19	0	0	5	6	8	4.16	3
Gardiner Chess non-coaching staff	4	0	0	0	0	4	5	0
Total	**273**	**27**	**27**	**65**	**83**	**71**	**3.53**	**38**
Respondent's School has a chess programme	221	14	21	53	70	63	3.67	28
Respondent's School does not have a chess programme	75	13	11	20	17	14	3.11	14
Total	**296**	**27**	**32**	**73**	**87**	**77**	**3.53**	**42**
State School	187	21	20	47	52	47	3.45	32
Anglican	22	1	3	6	6	6	3.59	0
Catholic	48	5	6	8	20	9	3.46	6
Private Non-Denominational	20	0	2	8	5	5	3.65	3
Other	21	1	2	2	6	10	4.05	2
Total	**298**	**28**	**33**	**71**	**89**	**77**	**3.52**	**43**

Table 6: Costs of Inter-School Tournaments are Reasonable

Q34 Costs of inter-school tournaments are reasonable (Average charge is $19 per student to participate in a one day inter-school tournament)	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	2	1	4	11	10	3.93	0
School Principal in a school with no coaching programme	24	2	4	7	7	4	3.29	0
Deputy Principal	18	2	0	5	9	2	3.5	0
Teacher Chess Coordinator (in charge of chess)	53	5	10	9	19	10	3.36	0
Parent Chess Coordinator (in charge of chess)	6	0	1	1	3	1	3.67	0
Teacher (not involved in chess)	12	1	1	2	4	4	3.75	0
Parent of student who receives weekly group chess coaching at school	109	1	3	18	41	46	4.17	0
School student who receives weekly group chess coaching at school (age required)	4	0	0	1	0	3	4.5	1
Gardiner Chess coach	18	0	1	5	6	6	3.94	0
Gardiner Chess non coaching staff	4	0	0	0	0	4	5	0
Total	**276**	**13**	**21**	**52**	**100**	**90**	**3.84**	**1**
Respondent's School has a chess programme	224	9	15	44	75	81	3.91	0
Respondent's School does not have a chess programme	75	4	9	16	31	15	3.59	0
Total	**299**	**13**	**24**	**60**	**106**	**96**	**3.87**	**0**
State School	190	10	14	40	71	55	3.77	0
Anglican	22	1	3	4	8	6	3.68	0
Catholic	48	2	4	12	16	14	3.75	0
Private Non-Denominational	20	0	2	2	6	10	4.2	0
Other	21	0	2	1	5	13	4.38	0
Total	**301**	**13**	**25**	**59**	**106**	**98**	**3.83**	**0**

Table 7: Many Children do not have Fun whilst Learning Chess

Q28 Many children do not have fun whilst learning chess	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	11	9	5	2	1	2.04	3
School Principal in a school with no coaching programme	24	11	4	7	1	1	2.04	0
Deputy Principal	18	8	1	7	2	0	2.17	4
Teacher Chess Coordinator (in charge of chess)	53	20	19	7	6	1	2.04	2
Parent Chess Coordinator (in charge of chess)	6	2	1	2	1	0	2.33	1
Teacher (not involved in chess)	12	5	2	3	1	1	2.25	0
Parent of student who receives weekly group chess coaching at school	108	40	32	26	9	1	2.06	7
School student who receives weekly group chess coaching at school (age required)	4	1	3	0	0	0	1.75	1
Gardiner Chess coach	19	6	9	2	2	0	2	7
Gardiner Chess non coaching staff	4	4	0	0	0	0	1	0
Total	**276**	**108**	**80**	**59**	**24**	**5**	**2.05**	**25**
Respondent's School has a chess programme	224	87	63	48	22	4	2.08	22
Respondent's School does not have a chess programme	75	28	23	16	7	1	2.07	6
Total	**299**	**115**	**86**	**64**	**29**	**5**	**2.07**	**28**
State School	191	66	59	45	18	3	2.13	14
Anglican	21	9	5	6	1	0	1.95	3
Catholic	48	18	13	7	8	2	2.23	6
Private Non-Denominational	20	11	6	2	1	0	1.65	1
Other	21	13	3	4	1	0	1.67	4
Total	**301**	**117**	**86**	**64**	**29**	**5**	**2.07**	**28**

From the information available, it seems that some state and catholic schools had more concern about the cost of chess services than their private counterparts, although due to the relatively low representation of private schools in the stats, this is by no means conclusive. Logically, it seems that for relatively poorer schools and families, the cost of learning chess is a key concern.

Table 6 provides a descriptive analysis of the answers to Q34 (Costs of Inter-School Tournaments are Reasonable). A significant majority of stakeholders agreed that the cost of inter-school chess is reasonable.

Table 7 indicates that most of the respondents do not agree with the proposition that many children do not have fun whilst learning chess. This was across all descriptives. The researcher's reading of the qualitative comments suggests that some children simply do not like or enjoy chess, and these children do not feel that it is fun. Also, it partly depends upon the ability of the coach to create the right environment for fun.

Table 8 shows that there is a moderately strong response to the proposition that chess has a good reputation in the community, although approximately ten per cent of respondents in each descriptive category slightly disagree. The issue of 'chess is for nerds' was brought up on several occasions in the comments section.

Table 9 shows a majority response of about two to one of those considering that chess is a sport compared with those that say it is not. Comments (table 11, question 30) indicate that this question is about dictionary definition, community attitudes and government funding.

Table 10 regarding special needs or academically-inclined students playing chess, had a very high 'neither agree nor disagree' response, and of those who did have an opinion, three to one were in favour of the proposition. Certainly, many special needs children play chess, as do many academically-inclined

children. However, there were several comments indicating that the question was poorly worded.

Table 8: Chess has a Good Reputation in the Community

Q29 Chess has a good reputation in the community	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	1	3	2	14	8	3.89	1
School Principal in a school with no coaching programme	24	1	3	6	10	4	3.54	0
Deputy Principal	18	0	3	3	8	4	3.72	4
Teacher Chess Coordinator (in charge of chess)	52	2	8	3	25	14	3.79	2
Parent Chess Coordinator (in charge of chess)	6	0	0	1	1	4	4.5	0
Teacher (not involved in chess)	12	0	1	2	5	4	4	0
Parent of student who receives weekly group chess coaching at school	109	0	6	17	42	44	4.14	2
School student who receives weekly group chess coaching at school (age required)	4	0	0	0	3	1	4.25	1
Gardiner Chess coach	19	0	3	3	5	8	3.95	5
Gardiner Chess non coaching staff	4	0	0	1	2	1	4	0
Total	**276**	**4**	**27**	**38**	**115**	**92**	**3.96**	**15**
Respondent's School has a chess programme	225	3	17	31	89	85	4.05	12
Respondent's School does not have a chess programme	74	1	10	13	33	17	3.74	6
Total	**299**	**4**	**27**	**44**	**122**	**102**	**3.97**	**18**
State School	190	2	18	27	77	66	3.98	12
Anglican	22	0	3	4	10	5	3.77	1
Catholic	48	2	4	11	17	14	3.77	2
Private Non-Denominational	20	0	1	2	9	8	4.2	1
Other	21	0	3	3	7	8	3.95	3
Total	**301**	**4**	**29**	**47**	**120**	**101**	**3.95**	**19**

Table 9: Chess is a Sport

Q30 Chess is a Sport	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	5	7	4	7	5	3	2
School Principal in a school with no coaching programme	24	4	4	4	5	7	3.29	1
Deputy Principal	17	1	2	5	3	6	3.65	4
Teacher Chess Coordinator (in charge of chess)	53	9	3	8	17	16	3.53	6
Parent Chess Coordinator (in charge of chess)	6	0	0	2	0	4	4.33	0
Teacher (not involved in chess)	12	3	1	2	3	3	3.17	2
Parent of student who receives weekly group chess coaching at school	108	11	16	29	25	27	3.38	12
School student who receives weekly group chess coaching at school (age required)	4	0	1	1	1	1	3.5	0
Gardiner Chess coach	19	1	0	4	5	9	4.11	4
Gardiner Chess non coaching staff	4	0	1	0	2	1	3.75	0
Total	**275**	**34**	**35**	**59**	**68**	**79**	**3.45**	**31**
Respondent's School has a chess programme	223	25	28	51	52	67	3.48	25
Respondent's School does not have a chess programme	75	9	7	15	21	23	3.56	8
Total	**298**	**34**	**35**	**66**	**73**	**90**	**3.5**	**33**
State School	190	27	23	38	48	54	3.42	19
Anglican	22	1	2	7	5	7	3.68	0
Catholic	47	6	8	13	10	10	3.21	6
Private Non-Denominational	20	1	1	5	6	7	3.85	5
Other	21	0	2	3	5	11	4.19	3
Total	**300**	**35**	**36**	**66**	**74**	**89**	**3.49**	**33**

Table 10: Special Needs or Academically-Inclined Children Play Chess								
Q31 Special needs or academically-inclined children play chess	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	3	0	14	4	7	3.43	1
School Principal in a school with no coaching programme	24	4	0	14	3	3	3.04	2
Deputy Principal	17	0	1	6	5	5	3.82	5
Teacher Chess Coordinator (in charge of chess)	53	2	3	17	19	12	3.68	4
Parent Chess Coordinator (in charge of chess)	5	0	1	3	1	0	3	1
Teacher (not involved in chess)	12	1	2	4	4	1	3.17	0
Parent of student who receives weekly group chess coaching at school	109	6	8	54	25	16	3.34	8
School student who receives weekly group chess coaching at school (age required)	4	2	0	1	1	0	2.25	1
Gardiner Chess coach	19	1	1	7	5	5	3.63	5
Gardiner Chess non-coaching staff	4	0	0	0	4	0	4	0
Total	**275**	**19**	**16**	**120**	**71**	**49**	**3.42**	**27**
Respondent's School has a chess programme	224	13	15	96	61	39	3.44	22
Respondent's School does not have a chess programme	74	7	2	38	13	14	3.24	10
Total	**298**	**20**	**17**	**134**	**74**	**53**	**3.41**	**32**
State School	190	10	10	86	47	37	3.48	19
Anglican	22	4	2	11	4	1	2.82	0
Catholic	48	3	4	24	10	7	3.29	7
Private Non-Denominational	19	2	1	8	6	2	3.26	2
Other	21	1	0	5	8	7	3.95	4
Total	**300**	**20**	**17**	**134**	**75**	**54**	**3.42**	**32**

There was a marginally positive response to the proposition that children who play popular sports (eg football, netball) are less inclined to play chess (Table 10).

However, there were several comments about children who are good at both chess and popular sports.

Table 11: Children Who Play Popular Sports are Less Inclined to Play Chess

Q32 Children who play popular sports (eg Football, Netball) are less inclined to play chess	Total Responses	Strongly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Strongly Agree	Weighted Average	Comments
School Principal in a school with a chess coaching programme	28	3	7	8	9	1	2.93	3
School Principal in a school with no coaching programme	24	4	6	6	7	1	2.79	0
Deputy Principal	18	4	2	6	5	1	2.83	4
Teacher Chess Coordinator (in charge of chess)	53	6	11	13	18	5	3.09	5
Parent Chess Coordinator (in charge of chess)	6	1	0	2	3	0	3.17	1
Teacher (not involved in chess)	11	2	1	2	6	0	3.09	1
Parent of student who receives weekly group chess coaching at school	109	19	19	32	35	4	2.87	5
School student who receives weekly group chess coaching at school (age required)	4	1	0	1	2	0	3	0
Gardiner Chess coach	19	3	4	4	6	2	3	8
Gardiner Chess non-coaching staff	4	2	1	0	1	0	2	0
Total	**276**	**45**	**51**	**74**	**92**	**14**	**2.92**	**27**
Respondent's School has a chess programme	225	40	39	60	73	13	2.91	25
Respondent's School does not have a chess programme	74	10	17	21	22	4	2.91	5
Total	**299**	**50**	**56**	**81**	**95**	**17**	**2.91**	**30**
State School	191	28	41	49	62	11	2.93	17
Anglican	22	7	4	4	6	1	2.55	2
Catholic	48	8	5	18	15	2	2.96	4
Private Non-Denominational	19	3	2	7	6	1	3	3
Other	21	4	4	3	8	2	3	4
Total	**301**	**50**	**56**	**81**	**97**	**17**	**2.92**	**30**

4.3 - Qualitative Data Analysis

In total there were 834 comments provided by respondents to the survey. The following are a selection of comments from the entire survey, which were provided in the open-ended comments section at the end of the survey. The following comments are provided to help reflect on what further research may be warranted. For a side by side analysis of quantitative and qualitative results see Table 12 which follows these comments.

- *As support teacher for Special Education & Learning Difficulties I can attest to the specific benefits of chess for this cohort. Our club has a significant number of students with ASD participating. They respond especially well to the individual challenges; the stable routines & most importantly to the rule governed nature of the game.*

- *I am so appreciative that we found the Chess club at school, my son was becoming disengaged and behind socially, he is ASD high-functioning, ADHD and ODD. Since starting classes he has become a full-time student and is managing social situations a lot better than before. Chess has pushed him to think in different ways from forward planning to analysing outcomes of various moves he may choose, he has gained confidence in himself and in his decisions, chess causes no anxiety for him when he is playing.*

- *I have had lots of success teaching kids with autism at a Sunshine Coast High School Special Ed Unit. They love it and it really calms them down.*

- *My ASD son has built new friendships, also the tournaments allow him to learn to cope in larger group settings.*

- *Our Chess Club is termed "quirky" - I am inspired by this diverse group who can be (over) excitable and need behavioural management. I'm finding that the individual challenge / desire to win is settling for many. Last year I had one student that just couldn't settle and he opted out of chess club. Interestingly he has returned this year, is willing to meet behaviour expectations, simply because he wants the peer recognition that has developed for our Chess Club.*

- *Definitely. The Gardiner Chess coaches last year in our end of session debriefing (we award 5 tournament place-getters plus 5 special recognition certificates per term) and they kept commenting on one Y1 student who was particularly noticeable in his chess skill development. This student has literacy learning difficulties, however is now showing above grade maths ability. I like the strategic nature of chess matching the strategic approach of my learning difficulties intervention programmes.*

- *I'm surprised to not hear mention of the links to coding seeing this is currently part of the Australian Curriculum and a focus area of development according to state and federal governments.*

- *Children love to keep score.*

- *Ongoing opportunities re planning and solving problems throughout the game.*

- *Visualisation and imagination especially.*

- *Structure of logical thinking in chess is similar to programming of software*

- *Chess playing certainly encourages innovation - coming up with plans to win! My oldest son, a chess player from a young age, has become a national manager working in a very large company. He wants innovative thinkers in particular - one of the questions on his job application is whether the candidate plays chess.*

- *An admirable skill in these days of instant gratification.*

- *Students, once they know the rudimentary rules of the game, begin to become more independent in their thinking and willing to take risks.*

- *Children understand that every defeat is a result of their own actions.*

- *This is one of the few games where students shake hands before and after the game. Our students learnt in chess there are only winners and learners.*

- *Based on our family experience - chess was attractive primarily due to its social nature. Our kids wanted to go because others were going to chess. It has improved our children's sportsmanship and is very good at enforcing acceptable behaviour. Our children were all academically inclined and we're sure chess supported their learning - especially problem solving, patience, persistence and being able to visualise cause and effect. None were high chess achievers but all of them had fun.*

- *Chess is one of the first extra-curricular activities my son has shown an interest in. I have noticed an improvement in his confidence in the short time he has been attending chess classes.*

- *Depending on what socio-economic background you come from, learning to play chess may or may not be expensive. For middle-upper income families (as in our case), chess classes are quite affordable and cheaper in comparison to other extra-curricular activities.*

- *Schools should invest in chess for their students and should take measures to remove impediments that some students may have in being able to access it.*

- *One of the first things my students learnt at chess was "it's better to have a bad plan than no plan at all."*

- *My son counts the days until he has chess lesson!*

- *There's, more often than not, a winner and loser, and I challenge anyone to sit down and concentrate for a few hours, round after round, and not feel exhausted!*

- *I believe my son has benefited from learning and playing chess. He plays physical sports and chess has given him an opportunity to increase his mental activity also. He thoroughly enjoys the game of chess and gets great enjoyment out of playing not only his parents, but also his grand-parents! This means that he is now more eager to spend time with the "older" generations as there is now some common ground.*

- *It's a reasonable charge, but it doesn't make it affordable for low socio-economic areas*

- *Chess has been a wonderful part of my children's childhood and development. In fact I think playing chess is the main reason my son actually made it through school in one piece. The social benefits are huge and children can make life-long friends all over the country and world. It helps in all aspects of their development and education.*

- *Chess is a great activity for all children to be involved in. It is one of a number of activities that schools can offer that assist in the academic, social and emotional development of children.*

- *I have always found that chess was a valuable experience in my life and I can only view it in a positive light. It has helped me in many ways that I hadn't thought about until this survey.*

- *I run my own chess club at my small school (34 students). Our greatest obstacles are time and getting to inter-school tournaments due to our rural and isolated location.*

- *My 10-year-old daughter has begun chess lessons for the first time this term. Not only was it an opportunity for her to learn how to play but for me also, she has also taught her older sister how to play and has matched her 81-year-old grandfather many times. Playing chess with my father, and watching my daughter play chess with him, is going to be such a special memory. Easily the best move I have made this year! :-)*

- *No matter who you are, your back ground or what you do chess is a universal language that connects all people. The benefits of learning chess flow far beyond the board. All schools should definitely have chess as part of the curriculum.*

4.4 - Synthesis of Qualitative and Quantitative Results: Analysis in Parallel

The following analysis examines the quantitative results of each survey question together with the comments of stakeholders and the researcher.

Table 12 - Analysis, Discussion and Comment (left) & Selected Comments by Respondent Stakeholders (right)	
Q1 Learning Chess has Educational Benefits for Children **313 Respondents; 5 disagreed or strongly disagreed; weighted average score/5 4.73; No of text comments 39**	
Questions 1-22 have common characteristics in responses across all demographics. Over 300 of the 316 respondents to this survey felt that chess has educational benefits for children and this was borne out by the many positive comments.	1. I grew up playing chess and it does help you to think critically and to take time before you make a decision. 2. Helped me as a child & now I'm a professor. 3. It helped me greatly with my school work. 4. Not simply cognitive but with confidence amongst peers and adults. 5. Not all children can benefit educationally.
Q2 Learning Chess has Benefits for Indigenous and Torres Strait Islander Children **314 Respondents; 4 disagreed or strongly disagreed; weighted average score/5 4.32; No of text comments 42**	
The researcher was a little disappointed by the comments concerning this question. He remembers very well having a conversation with a teacher from a school just over the border in NSW. She told him that she had aboriginal children in attendance, and she believed that chess suited them very well, because they seemed to have excellent pattern recognition, and excelling at chess might help their self-esteem	1. As it benefits all children, it would seem apparent that it would benefit Indigenous and Torres Strait Islander children equally. 2. Chess has benefits for all children. 3. It would be the same benefits for indigenous people as it would be for anyone else. 4. Learning chess would be beneficial to a child of any race. 5. Have not been able to get any of our indigenous students to participate - I think it is seen as too nerdy or uncool.
Q3 Learning Chess has Benefits for Children with various forms of Autism **313 Respondents; 3 disagreed or strongly disagreed; weighted average score/5 4.23; No of text comments 52**	
The comments in this section strongly reinforce the observations of the researcher during the 10 years he ran the Gardiner Chess centre. Whilst not every child with a form of autism benefits from playing chess, he has had several parents tell him that chess was mainly responsible for not only turning around behaviour problems but giving them the self-esteem that resulted in the improved behaviour. He saw that for himself, and the parents reinforced his perception.	1. As support teacher for Special Education & Learning Difficulties I can attest to the specific benefits of chess for this cohort. Our club has a significant number of students with ASD participating. They respond especially well to the individual challenges; the stable routines & most importantly to the rule governed nature of the game. 2. I am so appreciative that we found the Chess club at school, my son was becoming disengaged and behind socially, he is ASD high functioning, ADHD and ODD. Since starting classes he has become a full-time student and is managing social situations a lot better than before. Chess has pushed him to think in different ways from forward planning to analysing outcomes of various moves he may choose, he has gained confidence in himself and in his decisions, chess causes no anxiety for him when he is playing. 3. I have had lots of success teaching kids with autism at a Sunshine Coast High School Special Ed Unit. They love it and it really calms them down. 4. My asd son has built new friendships, also the tournaments allow him to learn to cope in larger group settings.

	5. Depends on the student and their strengths. Problems can arise with student's social interactions.
Q4 Learning Chess has Benefits for Socially Disadvantaged Children **311 Respondents; 5 disagreed or strongly disagreed; weighted average score/5 4.45; No of text comments 30**	
Winners of the four divisions of the Australian School Teams competition have by no means been limited to wealthy private schools. There have been many instances of state schools winning state and national titles. In the researcher's observation, it has normally come down to having a very enthusiastic chess coordinator and/or chess coach. Sometimes socially disadvantaged children have been able to succeed due to school assistance. Elsewhere in this survey the question of cost is addressed, and in most cases this applies to socially disadvantaged schools or students.	1. My school is in a lower socio-economic environment yet competed with success against more affluent schools. 2. If the costs are covered, a socially disadvantaged child could feel empowered by equal opportunity to succeed and demonstrating skills. 3. Previous teaching experience involved school identified as low socio-economic. I believe chess would be a fantastic opportunity for this group due to it's structure and need for solid focus. I think this diversionary aspect is an important aspect. 4. Learning to play chess places children in a social environment with other like-minded kids, where they can interact and develop positively. 5. I believe chess has great benefits for the child. It would be great if schools would fund a few places each year for children who come from disadvantaged backgrounds.
Q5 Learning Chess can have Benefits for Children with Behavioural Problems **313 Respondents; 4 disagreed or strongly disagreed; weighted average score/5 4.28; No of text comments 36**	
Many children with behavioural problems are somewhere on the autism spectrum. Even if they are not, in the researcher's observation at the chess centre many children with behavioural problems have got good at chess, their self-esteem went up, and as a result their behaviour improved. A local Grandmaster is a prime example. At the age of six he was a child who behaved badly. His parents discovered chess, very quickly he got very good at it, his self-esteem went up, and his behaviour was completely turned around. He became a well-rounded individual. This was to such an extent that he captained his high school team to three consecutive national titles and also to the world internet schools chess competition final held in New York, and now to being Australia's number two chess player. He has recently been awarded with his PhD.	1. Children with behavioural issues are often motivated by tactical strategy games like chess. 2. Behavioural problems is a very broad category, which can include completely unrelated behaviours. 3. Depending on the situation, chess can allow children with behavioural issues to develop inner discipline and intrinsic motivation. 4. Chess will be beneficial if the student is motivated to participate. Ethics in play could be an issue. Once again, predictable context structure is a positive. 5. Our Chess Club is termed "quirky" - I am inspired by this diverse group who can be (over) excitable and need behavioural management. I'm finding that the individual challenge / desire to win is settling for many. Last year I had one student that just couldn't settle, and he opted out of chess club. Interestingly he has returned this year, is willing to meet behaviour expectations, simply because he wants the peer recognition that has developed for our Chess Club.
Q6 Learning Chess has Benefits for Children with Learning Difficulties **309 Respondents; 5 disagreed or strongly disagreed; weighted average score/5 4.15; No of text comments 31**	

In the researcher's experience all 'types' of students can benefit by playing chess, and very often the same pattern emerges; the student's self-esteem goes up and the parents have a happier child. Some schools have a philosophy that they need to try and find at least one 'offering' for each child from which they can gain their self-esteem. Chess is an activity that fits very neatly between academics, sport, dance, drama, music, public speaking etc. and often appeals to students who have not yet found their 'thing'.	1. Definitely. The Gardiner Chess coaches last year in our end of session debriefing (we award 5 tournament place-getters plus 5 special recognition certificates per term) and they kept commenting on one Y1 student who was particularly noticeable in his chess skill development. This student has literacy learning difficulties, however is now showing above grade maths ability. I like the strategic nature of chess matching the strategic approach of my learning difficulties intervention programmes. 2. Being able to think ahead for chess moves may be impacted in students with learning disabilities. 3. Depends on the type of learning disabilities. 4. I see benefits of this in the cross section of children who have participated in chess at my primary over 10 years. 5. As stated, I live in a low SES area, with no budget to pay an outside provider to teach/coach our students. There are no teachers who play chess well enough to progress our students, so they rely on each other for any improvement. An online coaching program would be wonderful for our kids, and probably for some of the more remote areas of the country. What I like about chess at our school is that some of the less academically inclined boys actually enjoy playing and love the opportunity to wear formal uniforms to participate in the Tournaments. (Our school policy is that students representing the school at external functions must wear formal uniform.) It gives them a real self-esteem boost, especially if they pick up a merit ribbon!
Q7 Learning Chess helps Children Enhance their Numeracy Levels **311 Respondents; 5 disagreed or strongly disagreed; weighted average score/5 4.31; No of text comments 25**	
A very high positive result for this question, and it is hardly surprising. Even at the earliest stages of learning chess, children love to add up the value of the pieces that they have captured. The comment regarding coding is noted.	1. Adding up the number of points for a transaction of pieces is very good for thinking on your feet. 2. Any exchange of chess pieces requires some math operations. 3. Children love to keep score. 4. I'm surprised to not hear mention of the links to coding seeing this is currently part of the Australian Curriculum and a focus area of development according to state and federal governments. 5. It can't hurt numeracy levels but may not be overly beneficial. It certainly can have a positive impact on important higher level mathematical skills such as abstract thinking, reasoning, calculation, but may not have a similar impact on more basic numeracy development.
Q8 Learning Chess helps Children Enhance their Literacy Levels **312 Respondents; 21 disagreed or strongly disagreed; weighted average score/5 3.79; No of text comments 22**	
It is a little bit counter-intuitive that learning chess would help with literacy levels, but chess and reading scores have been linked by research. It is worth considering the report by Dr Stuart Margulies (1992). The Margulies report evaluated reading performance of 53 elementary pupils who did chess and compared their results with 1118 nonparticipants. Paired t-tests were used to evaluate the significance of reading gains within the chess group. Margulies also compared nonparticipants with chess participants by using the chi-square test. The conclusion was that participation in chess enhances reading performance. 'The results of the paired t-test were significant beyond the .01	1. Yes because it develops strategic thinking - the root of effective educational programmes. 2. Learning co-ordinates and memorizing openings is a literary genre. 3. Chess enhances and develops communication skills and social interaction increasing vocabulary and comprehension. 4. Chess would probably stimulate brain development hence enhancing the ability to read. A flow on effect? 5. There is no obvious link that I can see.

level. The chi-square test results of chess players in the computer-enhanced and high-scoring nonparticipants were significant at the .01 level. The comparison of results of chess players in the computer-enhanced program and all nonparticipants resulted in a chi-square=5.16, which is statistically significant at the .05 level.' While the study compares students with similar pre-test scores, its effects may be biased due to student self-selection into the chess program. There is a strong quantitative result for this research question/statement, but the qualitative comments are somewhat tenuous.	
Q9 Learning Chess helps Children Develop Problem Solving Abilities **310 Respondents; 3 disagreed or strongly disagreed; weighted average score/5 4.84; No of text comments 12**	
Both quantitative and qualitative responses to this question are powerful. Logically, for anyone who has ever played a game of chess, it would be hard to argue that not every move is a problem-solving exercise.	1. Every move in chess is solving a problem so this would have to enhance this skill. 2. As students become more competent players their level of problem solving (both solving and setting) becomes more in depth. 3. Absolutely - chess is one of the best ways I know that teaches students the importance of problem solving. They quickly learn to think before touching a chess piece and to plan ahead. Critical to the game of chess they are learning most through their mistakes - a great step for the ASD perfectionism trait. 4. Ongoing opportunities re planning and solving problems throughout the game. 5. What is chess other than problem solving?
Q10 Learning Chess helps Children Develop Critical Thinking Abilities **312 Respondents; 3 disagreed or strongly disagreed; weighted average score/5 4.82; No of text comments 9**	
Both quantitative and qualitative responses to this question are powerful. At all levels of chess, players critically examine their errors, and try to learn from their opponents when they lose. Players also learn to be critical of their own first choice of move, and to look for something better.	1. Winning chess demands critical thinking skills. 2. Looking at problems systematically. 3. Analysis of mistakes is incredible component of chess. 4. Students are encouraged to work through options, make decision and then continue to explore options. There are also time pressures in some competitions. 5. I know that Chess is a valuable conduit to learning logical thinking skills and critical thinking skills and this leads to stronger academic performances. It may be a coincidence, but it is rare - in my experience - to find an academically weak Chess student.
Q11 Learning Chess helps Children Develop Creative Thinking Abilities **312 Respondents; 5 disagreed or strongly disagreed; weighted average score/5 4.57; No of text comments 11**	
Whilst there is strong quantitative and qualitative approval for this question/statement, this is a matter which could be looked into in some depth. Some would say that creative thinking is necessary for innovation. Many moves in a game of chess are based upon what has been taught/learned, theory, pattern recognition and themes. A beginner who has only been taught the rudiments of how the pieces move and capture has far more scope to be creative than perhaps a Grandmaster. Just because a move has been made many times before, does not mean that it is not a creative move for someone who has never been taught the idea. The point is that at some stage in nearly every game, a player is faced with a situation they have never seen before, and can proceed creatively, or by critical analysis. A creative masterpiece	1. Students of chess are given a permanent starting point, however everything they do from there is an opportunity to be creative with how they develop their knowledge and skills. They need to take risks to improve. 2. Children have to invent every move during chess game. 3. Opportunities arise throughout the game naturally and this can be grown through lessons and game opportunities with post game reflection. 4. Visualisation and imagination especially. 5. Some players develop a more creative style this is probably utilized elsewhere.

can be constructed both by a devastating attack, or by slow, positional play.	
Q12 Learning Chess helps Children Develop Logical Thinking Abilities **312 Respondents; 3 disagreed or strongly disagreed; weighted average score/5 4.82; No of text comments 10**	
This is another question/statement with quantitative and qualitative approval. Logical thinking can be described as moving between related thoughts. This is precisely what a chess player does every single move when considering options for the next move(s). Logically, chess is a good form of exercise to improve logical thinking.	1. Structure of logical thinking in chess is similar to programming of software. 2. The basics of the game are highly structured and logical. 3. Success at chess demands logical thinking, from about the opening or position to even the psychology of the opponent. 4. As well as giving students the opportunity to be creative, within the confines of the chess board is the opportunity to logically work through the game in stages. Traditionally it was beginning game, middle game and end game. By knowing such a process, the student develop logical thinking abilities as they work from the end back. 5. Chess is a form of logic to a great extent and will be good training for other endeavours.
Q13 Learning to play Chess Develops Children's Imagination **305 Respondents; 8 disagreed or strongly disagreed; weighted average score/5 4.12; No of text comments 0**	
A strong quantitative result for this question, but for some reason there are no comments. Logically, with at least 10 comments for every other question, one would expect there would be at least a few comments to this question. Perhaps there was a glitch, or perhaps this question had responders a little stumped for an answer. It is well known that Grandmasters and other strong chess players can 'picture' a position in their mind. It is also known that they like to use the pieces on the board to 'picture' a checkmate, and then work back from there for a solution. So logically all players thinking ahead are trying to imagine where their plan leads to. Logically this is good practice for improving imagination.	No comments received for this question.
Q14 Learning to play Chess Develops Children's Ability to Innovate **311 Respondents; 9 disagreed or strongly disagreed; weighted average score/5 4.31; No of text comments 12**	
Another strong quantitative and qualitative result. One respondent relates 'innovation and imagination are components of creative thinking', whereas the researcher wonders if it really is that imagination and creative thinking are components of innovation. They all seemed to be strongly linked. The word 'innovation' seems to be a buzzword in Australian politics, and it might be very helpful to conduct a study into chess and innovation. The researcher believes he has read about a connection between reflection, creative learning and innovation, and chess would seem to be a logical test-bed.	1. Risk taking is part of playing a game of any sort and with that comes the opportunity for students to be innovative. 2. Chess playing certainly encourages innovation - coming up with plans to win! My oldest son, a chess player from a young age, has become a national manager working in a very large company. He wants innovative thinkers in particular - one of the questions on his job application is whether the candidate plays chess. 3. Depends partly on personality some people are more conservative. 4. Innovation and imagination are components of creative thinking. Grandmasters need these. 5. Looking for multiple solutions.
Q15 Learning Chess helps Children Improve their IQ Scores **312 Respondents; 13 disagreed or strongly disagreed; weighted average score/5 3.8; No of text comments 31**	
The quantitative result is powerful, but there are a minority of respondents who believe that one's IQ is solely determined by genetics.	1. Students may become better players through practice, but it won't improve their IQ. 2. Innovation, focus, concentration, imagination and thinking are some of the subskills which help to develop and grow intelligence.

	3. Chess is a sequence of problems to be solved. IQ by definition is problem solving ability. Other activities can do this too. 4. Children improve capacities in many areas related to IQ. 5. From my understanding, IQ is related more to genetics although chess may have an impact. I'm not sure to what degree.
Q16 Learning Chess helps Children with Concentration **313 Respondents; 4 disagreed or strongly disagreed; weighted average score/5 4.71; No of text comments 10**	
This question has a strong positive response both from quantitative and qualitative results. Children learn, often by a whole series of bitter defeats, that they need to take a lot more time over their moves, and use the time to consider more options, and examine them in more depth. As time goes on, students look harder and harder to find the best possible move, every move. This means using every second available on their clock concentrating hard trying to find the best continuation.	1. An admirable skill in these days of instant gratification. 2. Successes in chess are impossible without strong concentration. 3. Chess challenges students to remain focussed and also in a stationary position for extended periods of time and I believe allows students to extend their concentration as they become more knowledgeable about the game and can stay focussed for longer periods of time. 4. My Chess Club, is very energetic and excitable. We have learnt to quickly start the open games because the rule is no interruption, plus their energy is diverted to making choices on the chess board. 5. Right from when one sits down at the chessboard.
Q17 Learning Chess helps Children to become Independent Thinkers **314 Respondents; 2 disagreed or strongly disagreed; weighted average score/5 4.54; No of text comments 5**	
Another positive response both quantitative and qualitative. Even if a child has a private chess coach, there is only so much preparation that can be given for a game. There are so many possible combinations of moves in a game, that it is inevitable that the child will quickly be on his or her own. One of the joys of chess is that it is just you and your opponent, nobody else can get involved, and you can do your own thinking.	1. Children understand their own responsibility for every move. 2. Students involved in chess acknowledge that nobody can assist them in a game situation so must accept sole responsibility for their moves. 3. Students, once they know the rudimentary rules of the game, begin to become more independent in their thinking and willing to take risks. 4. Though chess can also be formulaic. 5. Helps to take on new ideas.
Q18 Boys and Girls Benefit Equally from Learning Chess **315 Respondents; 8 disagreed or strongly disagreed; weighted average score/5 4.66; No of text comments 18**	
Whilst there is powerful quantitative and qualitative approval for this question/statement, there were many different ideas thrown up. Clearly, worldwide, except for the Polgar experiment in Hungary, there are significantly more males playing chess than females. Also, whilst the top-ranked female in the world is ranked number 73, the researcher still thinks males and females have equal ability for chess. The Researcher's observations from when he used to run a lunchtime club every day at Somerset College were that usually there was an equal number of boys and girls playing. The girls would be talking about their pet dog, or their party on the weekend, and if they won it was nice and if they lost it was nice. Whereas for the boys it was just a matter of life or death. While there are always exceptions, boys generally seem to have far more desire to win at chess.	1. As far as learning goes, it's equal, but girls are under-represented in chess. 2. Chess might be a social asset for girls. Boys seriously involved in the game are more likely to become geeks and remain single. 3. It depends how much effort he or she puts in to the game. 4. I have had a few students choose this school because we have a chess club in addition to our academic credentials. Although we do not have any formal instruction in chess, we do provide some coaching two 40-minute lunch breaks each week. Chess still has some stigma attached to playing it among the student body, especially among the girls. Chess is seen as being somewhat unmanly or "nerdy", while at the same time among girls it is seen as a boy's only pastime. We have had some girls playing chess here, mainly when boyfriends have also been interested. 5. Last year was the best for building up my number of girls. Historically there has been much higher ratio of boys. The tool that works best for girls attendance is "invite a friend".

Q19 Learning Chess Teaches Children that they are Responsible for their own Actions **311 Respondents; 10 disagreed or strongly disagreed; weighted average score/5 4.25; No of text comments 8**	
Another strong quantitative and qualitative result for this question. The researcher finds it is very hard to get young children to slow down their moves. It can take a few years and many, many painful defeats for it to suddenly dawn on a child that they can do something about it. The researcher sometimes tries to tell a child that the computer programme that they are playing against makes much better moves the longer it is given to evaluate each move, and that their brain is no different in that context. But it makes no difference, and each child will choose their moment to take control and realise that they are responsible for their actions.	1. Children understand that every defeat is a result of their own actions. 2. Students as they develop become more forward thinking as they learn the game and are discerning about their move as they are aware that they will responsible for their own action. 3. Action and their choice can be seen with each move. Importance of helping child make this connection. 4. Not so much at the lower levels though this grows. 5. ..and that they need to think before acting.
Q20 Learning Chess Teaches Children to Win and Lose with Dignity **315 Respondents; 12 disagreed or strongly disagreed; weighted average score/5 4.43; No of text comments 27**	
In school chess coaching programmes, students are normally taught ethical considerations very early on. Most importantly to shake hands at the start and finish of each game and say something nice to their opponent. They are also taught to always treat their opponent with the utmost respect. Also, that by cheating, at the end of the day they are only cheating themselves. Most students quickly get into the routine of being ethical in their chess.	1. This is one of the few games where students shake hands before and after the game. Our students learnt in chess there are only winners and learners. 2. We keep up the protocols of the game and students always shake hands with opponent to introduce themselves and to thank the player for a good game regardless of result. 3. While there can be draws, having a winner and a loser certainly helps children to understand that concept of winning and losing. 4. Very strongly agree. 5. This is a skill which can be taught with the game of chess.
Q21 Learning Chess helps Children Develop Life Skills **312 Respondents; 11 disagreed or strongly disagreed; weighted average score/5 4.11; No of text comments 14**	
The researcher has learned many life skills from chess. For example, in chess he has often thought he fully understood a position, only for someone to tap him on the shoulder and suggest something he hadn't even considered. That has led him to check things more carefully, and question things that seem to his eyes to be illogical. Perhaps the most important life skill to learn from chess is logic.	1. I played all throughout primary school and high school. I love chess and I have found the lessons learnt in chess are helping me to study within university. I don't think anyone should be denied the opportunity however some people are just not interested in playing. 2. Yes, for causation understanding. 3. Students learn decision making and this can be juxtaposed into different life skills. 4. Teaches logical thought in solving life problems. 5. Chess masters are not always known for their life skills.
Q22 Learning Chess helps Children Practise Patience **313 Respondents; 6 disagreed or strongly disagreed; weighted average score/5 4.6; No of text comments 8**	
Patience in chess is an important component of managing the time available in a game of chess. Along with concentration, it is one of the hardest things to teach a young child, even though it is one of the simplest concepts. Inevitably, the longer a child learns chess, the more patient they become.	1. Chess study and thought processes will eventually make children more patient. 2. By Definition. Otherwise you lose consistently. 3. Competent primary school chess players will often play a game which lasts an hour - this requires patience. 4. Bullet and lightning aside. 5. Based on our family experience - chess was attractive primarily due to its social nature. Our kids wanted to go because others were going to chess. It has improved our children's sportsmanship and is very good at enforcing acceptable behaviour. Our children were all academically inclined and we're sure chess supported their learning - especially problem solving, patience, persistence and being able to visualise cause and effect. None were high chess achievers but all of them had fun.

Q23 Learning Chess is just for 'Nerds' **312 Respondents; neg 20 disagreed or strongly disagreed; weighted average score/5 1.29; No of text comments 17**	
Whilst there was correlation at the .01 or .05 level on nearly every question, this question provoked many interesting comments. There was certainly not a unanimous response in respondents' comments. The first comment came from a principal, who may not be interested in being socially correct. From all the comments, the researcher got the feeling that nerds in chess is still an issue, but it was generally felt that this is gradually changing. There was certainly plenty of evidence that it was certainly not mainly nerds who play chess, far from it. It is interesting that there were 834 comments supplied in the survey, and none mentioned that Asian families seemed to give chess far more importance in their child's education. That is certainly the researcher's experience.	1. I can see that there may be some advantages in some cases to students learning to play Chess. However, there is a social perception that it is an activity for the socially inept. As well as that, it takes quite some time to become proficient enough to be competitive and most students will not commit their time to such an activity. It is not immediately engaging to a lot of students and it is not an activity that I would put time or money towards on a large scale. 2. I feel that this used to be the case but isn't any longer as chess is slowly gaining momentum as a sport. 3. I have 2 children who started chess club. The older one 9yrs at the time dropped out after the first term, did not like the teacher from Gardiner chess, felt he was mean to him and was put off and has never returned to the game. This child was the one I thought would like it as he is a nerd. The younger child who is sporty and cool loves chess and continues to play with enthusiasm. 4. It would be great to be able to encourage more girls to participate, and I know that there are some Brisbane tournaments that focus on this. By and large the children who play chess appear to have above average intelligence with many of the really talented juniors getting scholarships to top SEQ schools. I think that playing chess helps their school learning, so chess complements and improves their performance. I don't necessarily subscribe to the view that they're smart already, so they play chess. There is certainly a bit of a view that older, adult, chess players are a bit weird/strange, but I don't get this perception from the current school age cohort. Hopefully as the current younger players age and become adults the 'chess is for nerds' view is diminished. In the end many of the talented juniors spend a lot of time playing chess and being coached and it's pleasing that, especially in QLD, there's an outlet for these children to perform and shine. 5. Most of the chess players at our school are NOT the nerds! (Surprising even to me!)
Q24 Learning Chess does not help Children Build Self Esteem **313 Respondents; neg 14 disagreed or strongly disagreed; weighted average score/5 1.68; No of text comments 15**	
I work regularly with a school, where the whole philosophy of the senior management team is about trying to have every student feel good about themselves in at least one discipline by the time they enter senior school. By this researcher's observation a significant number of students gain much of their self- esteem by being reasonably good at chess. There is also the issue that chess often appeals to students who have not yet quite found their 'thing', and accordingly often provides a high level of self-esteem.	1. This could be the one thing they find they are good at. It therefore gives them their sense of identity. 2. Any success builds self-esteem. 3. As they improve (as with other areas of their life) they can see the improvement which makes them feel good, which makes them strive to get even better. 4. Chess is one of the first extra-curricular activities my son has shown an interest in. I have noticed an improvement in his confidence in the short time he has been attending chess classes. 5. Depends if they are winning some games or get thrashed every time they play.
Q25 Learning to Play Chess is Expensive **312 Respondents; neg 51 disagreed or strongly disagreed; weighted average score/5 2.02; No of text comments 28**	

The question of cost, which is also applicable to questions 33 and 34, is the most contentious in this survey. It seems to me that reading all the comments, the majority believe the cost of learning chess is reasonable, but those attending low socio-economic schools, or the schools themselves, cannot afford chess. This is at the heart of the main research question 'Factors that influence schools to value or otherwise the teaching of chess to students'.	1. Depending on what socio-economic background you come from, learning to play chess may or may not be expensive. For middle-upper income families (as in our case), chess classes are quite affordable and cheaper in comparison to other extra-curricular activities. 2. I have been a strong supporter of Chess competitions in Mackay and have attended many State comps with students from previous schools I have been teaching; however, the school that I'm at now is much lower in SES and therefore unable to participate in coaching or competitions. Many families don't have transport to take their child to the venue even if the school funded the competition costs. We run a lunch time programme, but it is limited by the expertise of the teacher supervising the activity. 3. It is not the cost per child that is the killer, it is that if we are to send say more than 4 children to a competition we have to send a teacher along to supervise. At approximately $420 per TRS day this is a very expensive exercise for 8 - 10 students. 4. This activity is the least expensive of after school activities children attend here. 5. On par with other activities. Cheaper than an hour of after school care.
Q26 Chess should be a Fully Funded Activity offered by all Schools **315 Respondents; 34 disagreed or strongly disagreed; weighted average score/5 3.84; No of text comments 29**	
The quantitative findings were relatively strong, but the term over-crowded curriculum featured amongst the comments. Some respondents felt that schools should provide funding, whilst others thought it should be user pays. Overall there was a strong feeling that students should somehow be given the opportunity to learn chess.	1. Could be useful but it is a crowded curriculum. 2. Maybe not fully funded by schools depending on the schools' location and economic value but definitely should be offered to everyone. 3. Because of the educational benefits Chess should be part of the school curriculum. 4. Inexpensive as it is. But it should not be compulsory. 5. Schools should invest in chess for their students and should take measures to remove impediments that some students may have in being able to access it.
Q27 Learning Chess helps Children understand the Importance of Planning **314 Respondents; 4 disagreed or strongly disagreed; weighted average score/5 4.56; No of text comments 6**	
This falls into the same category as questions 1-22, with strong qualitative support. The comments support this, and logically much of chess, at least after reaching a certain standard, involves planning.	1. One of the first things my students learnt at chess was " it's better to have a bad plan than no plan at all." 2. Yes, you might play the opening well, but without logically forming a plan, you will muddle the middle game. 3. Success in chess is not possible without high planning skills. 4. As chess has an element of planning at more advanced levels especially this should be a benefit. 5. Children forward think as they develop their skills in chess.
Q28 Many Children do not have Fun whilst Learning Chess **314 Respondents; neg 36 disagreed or strongly disagreed; weighted average score/5 2.08; No of text comments 29**	
This question had a mild quantitative negative response to a negative question. It proved to be one of the most ambiguous. The researcher's observation is that there will always be some students who do not find chess to be fun. It does not appeal to everyone. The comments also make it clear that the coach has a lot to do with whether the students find the experience to be fun.	1. Children are often after instant gratification and success, chess encourages strategic thinking. To encourage enjoyment of chess different ways of playing for younger students could be explored such as having human chess pieces as well as larger pieces. 2. Depends on the chess teacher but it should be fun.

	3. Depends on the child. They might select it for a term activity, but due to lack of talent, might not want to complete the term. 4. I find most do, even the younger children. 5. My son counts the days until he has chess lesson!
Q29 Chess has a Good Reputation in the Community **314 Respondents; 37 disagreed or strongly disagreed; weighted average score/5 3.93; No of text comments 19**	
This is another question that had a fairly strong quantitative response, but was fairly ambiguous in the comments. The 'chess is for nerds' issue indicated more of a problem than in the 'nerds' question itself.	1. Depending on the community you're in. Some people think it's for nerds others think it's for everyone. 2. Chess had an outstanding reputation in our community. However a change of school personnel has seen the program fold. 3. I don't think Bobby Fischer helped, nor the musical 'Çhess' 4. Not in Australia, there is a general stigma associated. 5. I think it's generally seen as being for 'nerds' and boring but then as people hear about your child being able to play well, they do often then comment about how your child must be smart, so there's some positive correlation between chess and a good reputation.
Q30 Chess is a Sport **313 Respondents; 53 disagreed or strongly disagreed; weighted average score/5 3.5; No of text comments 35**	
A mildly positive quantitative response. It seems largely a question of dictionary definition, and community attitudes. At one stage the researcher was having meetings in Canberra at Parliament House with the Deputy PM and Minister of Sport about this issue and funding. Some dictionary definitions have chess as a pastime or even a sport. The researcher used to say that if you kick a soccer ball around the backyard it is a pastime, but if you play on a marked pitch with referee and touch judges, it is a sport. Likewise, if you play chess with your grandpa at home it is a pastime, but if you play in a tournament with an arbiter and clocks, it is a sport.	1. As a parent, I view chess as an analytical game, not a sport. 2. Depends on how the term sport is defined. 3. Just as much as darts or billiards are considered sports. 4. There's normally a winner and loser, and I challenge anyone to sit down and concentrate for a few hours, round after round, and not feel exhausted! 5. This argument is generally one about state funding. Is it active enough? Government here doesn't think so.
Q31 Special Needs or Academically-Inclined Children play Chess **313 Respondents; 37 disagreed or strongly disagreed; weighted average score/5 3.44; No of text comments 33**	
Poorly worded question featured several times in the comments. Upon reflection the researcher agrees. There was quite a good quantitative result for this question, and on the face of it the researcher can see why. In his opinion both academically-inclined and special needs students can both benefit, but for very different reasons.	1. I'm not academically good but I needed chess to get me into a good school, which it has happened. 2. Many students who play at our school have fitted this category. 3. Parents realise that chess improves educational performance and can help children with special needs in a very supportive environment. 4. ...but they're not the only ones. (perhaps a poorly-worded question). 5. This does also depend on the persons around these identified children.
Q32 Children who play Popular Sports (eg Football, Netball) are Less Inclined to Play Chess **314 Respondents; 111 disagreed or strongly disagreed; weighted average score/5 2.9; No of text comments 31**	
The quantitative response to this question was marginally in agreement with the statement. The comments were less clear, with more not agreeing with the statement. The researcher's reading of the responses is that there is a complete mix of students who play chess, ranging from those who are fixated on chess to the exemption of everything else, to those sporting	1. I believe my son has benefited from learning and playing chess. He plays physical sports and chess has given him an opportunity to increase his mental activity also. He thoroughly enjoys the game of chess and gets great enjoyment out of playing not only his parents, but also his grandparents! This means that he is now more eager to

leaders who regard their involvement in chess just as highly as the other sports.	spend time with the "older" generations as there is now some common ground. 2. I can only comment by looking at the students who play chess in my school - I would say about 50% play sport. 3. In a previous school we had a lot of success with the 'football' boys who loved chess. Chess became a signature strength of the school with students from all back grounds and levels of academic ability thoroughly enjoying and learning from the game. 4. My most successful chess teams consisted of well-rounded students who were involved in all aspects of school life. 5. My son loves his sports and chess equally.
Q33 The Cost of providing Chess Lessons at School is Reasonable (Average Charges range between $89 and $99 per Term, Per Student for a One Hour Lesson each week) **311 Respondents; 62 disagreed or strongly disagreed; weighted average score/5 3.52; No of text comments 43**	
Q33 and Q34 - in both cases there is a mildly strong quantitative response that charges are reasonable. The comments highlight socio-economic issues as being the main factors affecting whether the fees are affordable. These two questions can be considered alongside Q25.	1. $9 - $10 per student per hour in a group setting is unreasonable. As a classroom teacher with 28 students in a large group setting, should I be charging 28 x $10 x 5 hours = $1,400 per day for my professional knowledge? 2. Costs much more in Sydney. 3. It is reasonable in that we can just afford it - I believe the benefits of chess are high so we make sacrifices elsewhere in our budgeting. 4. It's a reasonable charge, but it doesn't make it affordable for low socio-economic areas. 5. I work in a low socio-economic area and many parents cannot afford extra fees. In a different local, I would agree that $99 per term is reasonable.
Q34 Costs of Inter-School Chess Tournaments are Reasonable (Average Charge is $19 Per Student to participate in a one-day inter-school Tournament) **314 Respondents; 39 disagreed or strongly disagreed; weighted average score/5 3.83; No of text comments 0**	
Q33 and Q34 - in both cases there is a mildly strong quantitative response that charges are reasonable. The comments highlight socio-economic issues as being the main factors affecting whether the fees are affordable. These two questions can be considered alongside Q25.	1. We went to our first tournament and was a bit surprised it was $18 for a child. I would have thought $10 would be more reasonable. 2. Why are there any costs for inter school tournaments? It costs nothing to run a game of chess. 3. The school pays for the bus to transport the children otherwise it would be out of our reach as an excursion 4 times per year. 4. Most students are not able to pay the entry fee for competitions and the school uses funding to ensure students have equal opportunity to be able to participate. 5. Think this cost is too high for each child, especially when a teacher is there and is in charge of the group of participants.

4.5 - Survey Conclusion

Analysing the research data was an intensive, rich and rewarding exercise. Comparing quantitative data with text comments helped in logically making meaning out of numbers.

The analysis process was effective at meeting this researcher's learning objectives of tolerance for ambiguity, analytical skills, industry knowledge, and critical and objective judgement.

The main research question (provided as a statement) Q1 'Learning Chess has Educational Benefits for Children' was answered with a resounding 'yes' by a significant majority of respondents, and this was backed up by a similar response to each of the perceived specific benefits in questions Q2-Q22 and Q27. Each stakeholder group emphatically agreed that the various skills described in those questions had educational benefits for children. Very few respondents slightly disagreed or strongly disagreed with the statements in these questions. Whilst stakeholder beliefs cannot be regarded as proof that chess has educational benefits for children, the fact that all stakeholder groups, including school principals, almost unanimously agreed on the matter are a powerful argument for other schools to include chess coaching programmes in their offerings.

The strongest argument for dealing with the workplace problem of getting more schools involved in providing chess coaching for students, is indicated by the strength of feeling of stakeholders of the various educational benefits of children learning chess.

The question of affordability for schools and individuals living in low socio-economic areas came through strongly in Tables 4, 5 and 6. The comments for questions Q25, Q33 and Q34 in table 12 make this clear. This should be considered by organisations such as the Department of Education and the Catholic Education Office. A majority of respondents to Q26 in table 2 believe that chess should be a fully funded activity offered by all schools. However, comments for the same

question in table 12 can see problems with this. Stakeholders have provided evidence that all schools should consider providing a chess coaching option to students.

The survey threw up a few other subsidiary issues which have been studied with the use of tables and comments. The perception that chess is just for ‘nerds’ is still out there in the community, although there are signs that this is steadily changing. The comments for Q23 in table 12 seem to confirm this.

There is evidence that many children who love chess or excel at it are also excellent at other sports. The comments for Q32 indicate a small majority believe that students who like the popular sports are less likely to choose chess.

There were many comments indicating that chess may well have significant benefits for children with various forms of autism, and those with behavioural problems, learning difficulties or special needs. These comments add to arguments elsewhere in this paper that more research in the field of chess and children with ADHD would be useful.

Chapter 5 – Results and Discussion – The Main Study

Table 13: Main Study - all students								
Year Level with approx mean age at March 2017	Number	Chess Only	Music Only	Both	Neither	All Chess	Male	Female
Grade 1 - 6.5 years	38	14	6	10	8	24	22	16
Grade 2 - 7.5 years	35	12	7	8	8	20	20	15
Grade 3 - 8.5 years	34	5	9	3	17	8	16	18
Grade 4 - 9.5 years	56	7	12	11	26	18	32	24
Grade 5 - 10.5 years	40	8	14	5	13	13	27	13
Total	**203**	**46**	**48**	**37**	**72**	**83**	**117**	**86**

The researcher proposes that students who did extra chess would, at some level, achieve greater improvement in cognitive thinking scores as measured by the RPM and AGAT tests than non-chess children, and children who only did one lesson per week.

5.1 - The philosophy of the school

The school encourages those who are charged with providing services to students to do everything possible to enable students to take the activity, whether it be chess, rugby, rowing or anything else, as far as they wish. The chess programme at the school has a long history of being true to this philosophy. Some students just do the weekly chess lesson, but many regularly attend lunchtime club, others play regularly at home, and those who are keen attend out of school club and receive regular private chess lessons at home.

A total of 203 students (by their own, and their parent's permission), from a grade 1-5 cohort of 453, opted-in to the study, and they make up the following groups:

Group A

Grade 1	38
Grade 2	35
Grade 3	34

Grade 4	56
Grade 5	40
Total	203

Group B

Chess Only	46
Music Only	48
Both	37
Neither	72
Total	203

Group C

Chess	83
Music	85

5.2 Frequencies

The study involved 203 students of whom 117 (58%) were males and 86 (42%) females. Interestingly, and perhaps contrary to some stereotypes regarding males and females in chess, there were no correlation tests that indicated significant gender differences. Only the 83 chess students in the study completed the survey.

5.3 – Discussion of Frequencies

Of the 83 students who completed the survey in the main study, 93% of students said they enjoy their regular chess lessons; 61% said that if they had a choice they would do more chess; 55% said they learn chess because it is fun and 88% of students said that chess is great. Further 75% play regular chess at home, whilst 48% play extra chess at school; 63% said they play regular chess at home on the internet and 69% said that they had represented Somerset College at an inter-school chess competition during the year. Interestingly 66% of students thought that chess helped them to concentrate better in class. These results indicate there is a positive learning environment for the chess cohort. This is reinforced by the open-ended responses from students shown in Appendix 1 that showed many students thought that chess is great, is fun and they love it.

Table 14 - Main Study - Survey Frequency Table
83 Chess Students

Number	%	Findings
14	17	A relatively small number of students said they first learned chess this year
50	60	Quite a large proportion said they were first taught chess by the chess teacher at Somerset College, whereas 29 said they were taught by a family member
73	88	Most students said that chess is great whilst 10 said it is just ok
55	66	A significant proportion of students reported that learning chess helps them to concentrate better in class, whilst 24 said they did not know
46	55	A majority said they learn chess because it is fun, whilst 21 said they did so to make them a better thinker
20	24	24 students said that they learn, practice or play chess most days, 34 said 'some days' and 22 said once a week
62	75	Most said that they played regular chess at home with their family, whilst 17 said that they didn't
52	63	Most students said that they played regular chess at home on the internet, whilst 28 said that they didn't
6	7	Only 6 students said that they were a member of an out of school chess club
57	69	Most students said that they had represented Somerset College at an inter-school chess competition during the year, whilst 22 said they had not
46	55	A majority said that they had used a chess clock, whilst 34 said they had not
23	28	A minority said that they had played in a chess tournament involving adults and clocks during the year, whilst 53 said that they had not
24	29	A minority said that they had used scoresheets in a game of chess, whilst 55 said they had not
40	48	Just over half of the chess students said that they do regular extra chess at school each week (either lunchtime club or library), whilst 39 students said they did not
11	13	A small group said they did regular private chess lessons at home, whilst 72 said they did not
24	29	A minority said they had a QJ rating, whilst 59 said they did not or were unsure
32	39	Under half the students said that the regular weekly chess lesson was the only chess they did each week, whilst 48 said it was not
51	61	Most students said that if they had the choice they would do more chess each week, whilst 21 said 'about the same'
77	93	Virtually all students said they enjoyed their regular chess lessons, whilst 2 said they did not
65	78	A large majority of students said that they do the regular chess lessons because they want to, and 10 because their parents say they must
18	22	A relatively modest number of students say they get extra (non-chess) tuition each week from a company like Kip McGrath etc, and 65 say they do not
7	8	A small number say that they get private home tuition in things like Maths and English (not chess), and 76 say they do not

The low number of students who attended out of school club (6) and private lessons (11) in this study is a concern for the validity of findings, since these are the strongest chess players and are considered by the researcher as the most likely to show improvements in test scores higher than the other cohorts.

There was a higher number of students receiving extra non-chess tuition, which could be confounding factor for the results.

The researcher, *a priori*, regarded the following indications of extra chess, as being the most likely to show a measurable improvement in cognitive thinking scores (in brackets, number of students out of 83).

	%
Improvement in QJ (Queensland Junior) rating (18)	21
Private chess Lessons (11)	13
Regular attendance at out of school club (6)	07
Attendance at a chess tournament with adults and clocks (23)	28
Possession of a QJ rating (start of year 18, end of year 26) (31)	26
Regular attendance at lunchtime club (40)	48
Participation in Inter-school chess tournament(s) (57)	69

5.4 Correlations

The correlations matrix that is shown in Table 15 seeks to analyse the important correlations based upon the significance and correlation coefficients, as well as the clustering of relationships.

The researcher examined groups correlating at a lower level and found conflicting or confusing results that were not used. For example, many students say they have used a chess clock or know how to keep a scoresheet. However, every student gets taught how to use a clock and how to keep a scoresheet in their lessons and get to practice these also in their lessons. The students were asked if they had a QJ rating. The researcher checked the QJ list, and several students who said they had a QJ rating did not in fact have one. The researcher added the QJ ratings of all students directly from the official list to the SPSS file for analysis.

Table 15 - Chess and Cognitive Thinking Survey - Correlations

Gr 1-5 Survey Correlations – 83 students				Corr	Comments
Survey Question	**Code**	**Variable**	**Sig**	**Coeff**	
Queensland Junior Chess Ratings where applicable for January 2017	QJRLJANBEF	REGULARITY	*	-0.488	Having a high QJRL rating appears to be an indication that the child is more likely to have private lessons, more likely to be a member of an outside chess club and is more likely to play regularly. Interestingly, the child also seems to be more likely to receive non-chess home tuition and attend a non-chess tuition company. There is a strong correlation between having a QJRL rating, having a private chess coach and attending an outside chess club.
		OUTSIDECLUB	**	-0.737	
		PRIVATELESSONS	**	-0.757	
		TUITONCOMPANY	*	-0.506	
		HOMETUITION	*	-0.501	
Queensland Junior Chess Ratings where applicable for January 2018	QJRLJANAFT	MOTIVELEARNCHESS	*	0.425	
		REGULARITY	*	-0.489	
		OUTSIDECLUB	**	-0.703	
		ADULTSCLOCKS	**	-0.515	
		SCORESHEET	*	-0.492	
		PRIVATELESSONS	**	-0.729	
		HOMETUITION	**	-0.627	
When did you first learn chess?	STARTEDCHESS	YEAR2TESTS	**	0.629	Perhaps year 2 and 5 students with high test scores are more likely to have started chess earlier.
		YEAR5TESTS	**	0.773	
Regarding playing chess, do you think it is?	MOTIVEPLAYCHESS	YEARLEVEL	**	-0.356	There is a weak to moderate correlation in these two questions that seems to suggest that the longer the child

		STARTEDCHESS	**	-0.291	has been involved in chess, the less likely they are to think that chess is great.
		MOTIVECONCENTRATE	*	0.277	There seems to be a close relationship between this group and the 'parent' group below. They chose to do chess, they think chess is great, they play at home, they play chess regularly, they would do more chess if they could, they are motivated by their chess teacher and they play in the inter-school competitions. This group are possibly a less competitive group than the 'private lessons/outside club' group.
		REGULARITY	**	0.292	
		HOME	*	0.266	
		INTERSCHOOL	**	0.348	
		CHOICE	**	0.405	
Do you learn, practice or play chess?	REGULARITY	QJJAN	*	-0.488	This suggests that playing chess more regularly helps increase the child's rating and that they are more likely to know how to keep a scoresheet.
		QJNOV	*	-0.444	
		SCORESHEET	**	0.453	
Do you play regular chess at home on the internet?	INTERNET	YEAR5TESTS	*	0.562	Perhaps year 5 students are more likely to play chess on the internet at home.
Are you a member of an out of school chess club?	OUTSIDECLUB	QJJAN	**	-0.737	This seems to be a fairly strong indication that students who are a member of an outside of school chess club are likely to have a private chess coach and a higher chess rating.
		QJNOV	**	-0.691	
		PRIVATELESSONS	**	0.518	
Have you represented Somerset College in an inter-school chess competition this year?	INTERSCHOOL	YEARLEVEL	**	-0.406	This is rather a weak correlation, but it seems to suggest that the older children are more likely to have played in the inter-school competition during the year, and curiously that they are less likely to think that chess is great. Perhaps this simply means that the younger students are more enthusiastic, and that to some extent this wears off over time.
		STARTEDCHESS	**	-0.359	
		MOTIVEPLAYCHESS	**	-0.348	
Have you ever used a chess clock?	CLOCK	YEARLEVEL	**	-0.324	The question relating to clocks was probably badly worded because every child learns to use a clock in their weekly chess lessons. The rather weak correlation with several variables, especially year tests, is most puzzling.
		STARTEDCHESS	**	-0.417	Perhaps it means that stronger players are more likely t have used clocks, are more likely to
		SCORESHEET	**	0.347	

		PRIVATELESSONS	**	0.332	use scoresheets, are more likely to have been playing chess for longer and are more likely to take private chess lessons. Also, year 2 and 5 students who are more likely to have used clocks are more likely to have higher test scores.
		YEAR2TESTS	**	-0.578	
		YEAR5TESTS	**	-0.746	
Have you played in any chess tournaments involving adults and clocks this year?	ADULTSCLOCKS	QJNOV	*	-0.471	
Do you know how to keep a scoresheet in a game of chess?	SCORESHEET	QJNOV	*	-0.456	Scoresheets give similar results to Clock, and this is almost certainly because when one uses one, one uses the other as well. This question was also poorly worded because every child doing weekly chess learns how to write a scoresheet. The relationship with year tests is quite puzzling.
		STARTEDCHESS	**	-0.332	Perhaps even with the weak correlation there is a hint that students who know how to use scoresheets are more likely to have been playing chess longer, playing more regularly, know how to use a clock and are more likely to have private chess lessons.
		REGULARITY	**	0.453	
		CLOCK	**	0.347	
		PRIVATELESSONS	**	0.36	
		YEAR4TESTS	*	-0.521	
		YEAR5TESTS	*	-0.556	
Do you do any extra chess at Somerset College each week (eg., lunchtime chess club, casual chess games in the library)?	LUNCHTIME	YEAR3TESTS	*	0.768	This fairly high correlation is isolated and difficult to interpret. Perhaps it means that year 3 students who attend lunchtime club are less likely to have good test results.
Do you have regular extra chess coaching at your home from a private chess coach?	PRIVATELESSONS	QJJAN	**	-0.757	Normally only the keenest chess students, supported by their parents, take private chess lessons at their home. These correlations tend to suggest that taking private chess lessons correlates with higher chess ratings, attending outside school chess club, having non-chess tuition at home, and lower test results in grade 3.
		QJNOV	**	-0.7	
		OUTSIDECLUB	**	0.518	
		TUITIONCOMPANY	**	0.384	
Is your regular co-curricular chess lesson at Somerset College the only chess you do each week?	ONLYLESSONS	STARTEDCHESS	**	0.421	This seems to mean that students who only do the one chess lesson each week are more likely to have started chess this year.
If you had a choice, would you do?	CHOICE	MOTIVEPLAYCHESS	**	0.405	This fairly weak correlation tends to suggest that students who, given the choice, would do more chess are more likely to think that chess is great, more
		MOTIVECONCENTRATE	**	0.336	

		INTERNET	**	0.339	likely to think that chess helps them to concentrate, more likely to play chess on the internet at home and more likely to have chosen to play chess themselves.
		PARENT	**	0.352	
Do you enjoy your regular co-curricular chess lessons at Somerset College?	TEACHER	MOTIVEPLAYCHESS	**	0.395	This fairly weak correlation again seems to mean that the child thinks that chess is great, they enjoy their weekly lesson and they made their own choice to play chess.
		PARENT	**	0.372	
Do you learn chess at Somerset College each week because you really want to, or because your parents say you must?	PARENT	MOTIVEPLAYCHESS	**	0.398	There appears to be a weak to moderate relationship between children who chose to play chess and those children thinking that chess is great, they play extra chess at home with their family and at school in lunchtime club, if they could they would play more chess and their teacher is a motivation.
		HOME	**	0.312	
		LUNCHTIME	**	0.332	
		CHOICE	**	0.352	
		TEACHER	**	0.372	
Regarding extra learning for other things like maths and English (not chess), have you been regularly attending a company like Kumon, Kip McGrath, North Shore or James An?	TUITIONCOMPANY	QJJAN	*	-0.506	Perhaps this correlation means that children who attend a non-chess tuition company, are more likely to have private chess lessons and to have a higher chess rating. Perhaps it could also mean that parents who have both forms of tuition want to give their child the best chances of succeeding academically
		PRIVATELESSONS	**	0.384	
Regarding receiving regular home tutoring for other things like Maths and English (not chess), has a home tutor been teaching you?	HOMETUITION	QJJAN	*	-0.501	This seems to suggest that children who have non-chess home tuition are more likely to have a higher chess rating.
		QJNOV	**	-0.583	This seems to suggest that children who have non-chess home tuition are more likely to have a higher chess rating.
Year 1 Tests	YEAR1TESTS	CHESSCOACH	*	-0.437	A possible meaning is that the particular chess coach is a factor in year 1 test scores.
Year 2 Tests	YEAR2TESTS	STARTEDCHESS	**	0.629	Higher test scores in year 2 seem to correlate with having started chess earlier and not having used a clock. Puzzling.
		CLOCK	**	-0.578	
Year 3 Tests	YEAR3TESTS	LUNCHTIME	*	0.768	Higher year 3 test scores appear to correlate with not attending lunchtime club and not having private chess lessons.
		PRIVATELESSONS	*	0.741	
Year 4 Tests	YEAR4TESTS	SCORESHEET	*	-0.56	Higher year 4 test scores seem to correlate with having used a scoresheet and with having a high chess rating.
		QJRATING	*	-0.582	

Year 5 Tests	YEAR5TESTS	STARTEDCHESS	**	0.773	Higher year 5 test scores appear to correlate with having played chess longer, not playing chess at home on the internet, having used a chess clock, having used a scoresheet and with having a high QJ rating.
		INTERNET	*	0.562	
		CLOCK	**	-0.746	
		SCORESHEET	*	-0.556	
		QJRATING	**	-0.736	

5.5 - Overall Insights

This researcher is particularly interested in whether playing significantly more chess, receiving extra chess coaching and having a high chess rating results in higher test scores than students who do less chess, or no chess. One of the clearest correlations in this section is between a student having private lessons, being a member of an outside school chess club and having a Queensland junior chess rating. This is logical because students are not normally offered private lessons until they have a QJ rating.

Interestingly, for this strong chess group, there is a correlation with attending a non-chess tuition company, and with receiving home tuition from a non-chess tutor. The home tuition could mean that the parents are trying to ensure good academic results for their children. It could also be a confounding factor for good test scores by the strong chess group.

This researcher and his supervisor both, as children, had a fascination with chess clocks and scoresheets. It seemed to somehow signal a ‘rite of passage’ from ’beginners’ to ‘serious chess players’. When young, it seemed like only the best players used clocks and scoresheets. In those days there were no ratings lists for children. Perhaps the moment children start to use scoresheets and clocks coincides with the moment the student moves from ‘not having a rating’ to ‘having a rating’. It is difficult to know what to make of some of the correlations relating to clocks and scoresheets. There does not seem to be any pattern, and the correlations are not strong.

The Queensland Junior ratings list starts with a minimum rating of 500, which roughly equates to knowing how to move the pieces correctly, how to castle correctly, how to make safe moves and how to do some basic random checkmates. This ratings list, voluntarily managed by Dr David McKinnon, who resides in Brisbane, is based upon the theories of Professor Elo (1978). The list was started in 1993 by Dr McKinnon with 113 students and has now grown to approximately 3,500. Ratings lists are used to give incentive and feedback to players and are used to seed players in competitions. To give perspective, the strongest juniors in Queensland usually have a rating around 2,000, Grandmasters start at 2,500, the world champion is rated around 2,840 and the computer programme Stockfish, operating on a regular smartphone at its highest level, is rated around 3,300. The scale of the Queensland Junior chess ratings list roughly coincides with Australian and world chess ratings and its workings are explained at https://gardinerchess.com.au/qj-ratings-faq/.

There was quite a large group of students in the study who thought chess was great and given the chance they would play more chess. They chose to do chess, they think chess is great, they play chess at lunchtime club, they play at home, they play chess regularly, they would do more chess if they could, they are motivated by their chess teacher and they play in the inter-school competitions. Because they do not have private lessons and are not a member of an out of school chess club, it could mean that this group is less competitive. Or perhaps their parents think they have enough competing interests. These correlations tend to reinforce the frequency report in the descriptive statistics, which highlighted a fairly large group with several similar characteristics, which did not do private lessons or attend out of school chess club.

5.6 - Analysis of Manova

The researcher believed that students having just the weekly 30-minute chess lesson would not perform better on the school cognitive thinking tests than the three control groups, but at some level of extra chess they would. A series of multivariate analysis of variance tests (Manovas) were conducted. Manovas test hypotheses with regard to the effect of one or more independent variables on two or more dependent variables.

Grade 1 Manova Statistics – 38 Students

Study Groups	1 Chess Only	14
	2 Music Only	6
	3 Both	10
	4 Neither	8
Gender	1 Male	22
	2 Female	16

Grade 1 PC Increase

	Gender	Mean	Std Deviation	Number
Chess Only	Male	2.8253	11.81625	9
	Female	11.7522	9.28953	5
	Total	6.0135	11.49688	14
Music Only	Male	6.4815	13.98117	3
	Female	1.4029	17.38258	3
	Total	3.9422	14.38014	6
Both	Male	12.1092	12.79797	7
	Female	1.4029	21.80400	3
	Total	8.8973	15.54302	10
Neither	Male	5.5556	9.62250	3
	Female	2.7778	17.23566	5
	Total	3.8194	14.08101	8
Total	Male	6.6502	11.99167	22
	Female	5.0667	15.09704	16
	Total	5.9834	13.21530	38

The grade 1 one-way Manova test is not significant V = .031, F (6, 60) = .159, p = .986. Group and Gender Pairwise comparisons are not significant.

Grade 2 Manova Statistics - 35 students

Study Groups	1 Chess Only	12
	2 Music Only	7
	3 Both	8

	4 Neither	8
Gender	1 Male	20
	2 Female	15

Grade 2 PC Increase

	Gender	Mean	Std Deviation	Number
Chess Only	Male	7.3333	20.50595	10
	Female	15.0000	14.14214	2
	Total	8.6111	19.26468	12
Music Only	Male	29.1667	17.67767	2
	Female	4.6667	21.48643	5
	Total	11.6667	22.42271	7
Both	Male	-4.2451	17.03964	5
	Female	3.3333	2.88675	3
	Total	-1.4032	13.55281	8
Neither	Male	16.1111	22.68953	3
	Female	11.3333	10.89087	5
	Total	13.1250	14.86547	8
Total	Male	7.9387	20.69259	20
	Female	8.0000	14.17297	15
	Total	7.9650	17.94414	35

The grade 2 one-way Manova test is not significant V = .256, F (6, 54) = 1.322, p = .263. Group and Gender Pairwise comparisons are not significant.

Grade 3 Manova Statistics - 34 students

Study Groups	1 Chess Only	5
	2 Music Only	9
	3 Both	3
	4 Neither	17
Gender	1 Male	16
	2 Female	18

Grade 3 PC Increase

	Gender	Mean	Std Deviation	Number
Chess Only	Male	12.6389	11.73591	4
	Female	13.3333	.	1
	Total	12.7778	10.16834	5
Music Only	Male	10.0000	17.28483	2
	Female	13.9009	13.50471	7
	Total	13.0340	13.30742	9
Both	Male	11.1111	9.42809	2
	Female	4.4444	.	1
	Total	8.8889	7.69800	3
Neither	Male	11.5972	13.69045	8
	Female	13.0864	12.09246	9
	Total	12.3856	12.47801	17
Total	Male	11.5972	11.89611	16
	Female	12.9368	11.74000	18
	Total	12.3064	11.65285	34

The grade 3 one-way Manova test is not significant V = .227, F (6, 52) = 1.110, p = .369. Group and Gender Pairwise comparisons are not significant.

Grade 4 Manova Statistics - 56 students

Study Groups	1 Chess Only	7
	2 Music Only	12
	3 Both	11
	4 Neither	26
Gender	1 Male	32
	2 Female	24

Grade 4 PC Increase

	Gender	Mean	Std Deviation	Number
Chess Only	Male	.4444	7.09721	5
	Female	13.3333	15.71348	2
	Total	4.1270	10.69045	7
Music Only	Male	3.1111	6.20633	5
	Female	3.8095	4.19961	7
	Total	3.5185	4.87402	12
Both	Male	4.3476	7.61982	9
	Female	2.2222	9.42809	2
	Total	3.9612	7.48848	11
Neither	Male	1.6088	8.32855	13
	Female	6.6667	6.84935	13
	Total	4.1378	7.90347	26
Total	Male	2.4319	7.44077	32
	Female	6.0185	7.16283	24
	Total	3.9690	7.47453	56

The grade 4 one-way Manova test is not significant V = .051, F (6, 96) = .420, p = .864. Group and Gender Pairwise comparisons are not significant.

Grade 5 Manova Statistics - 40 students

Study Groups	1 Chess Only	8
	2 Music Only	14
	3 Both	5
	4 Neither	13
Gender	1 Male	27
	2 Female	13

Grade 5 PC Increase

	Gender	Mean	Std Deviation	Number
Chess Only	Male	6.0399	11.03134	7
	Female	4.4444	.	1
	Total	5.8405	10.22861	8
Music Only	Male	8.7556	9.18769	10
	Female	13.3333	10.10236	4
	Total	10.0635	9.30579	14
Both	Male	19.1111	17.43371	4
	Female	15.5556	.	1
	Total	18.4000	15.18154	5
Neither	Male	7.8519	8.00823	6
	Female	6.9841	6.71937	7
	Total	7.3846	7.03557	13
Total	Male	9.3848	11.08899	27
	Female	9.4017	7.86480	13
	Total	9.3903	10.05035	40

The grade 5 one-way Manova test is not significant V = .200, F (6, 64) = 1.185, p = .326. Group and Gender Pairwise comparisons are not significant with one exception. There is a significance on the pretest pairwise comparison scores for the 'Both' group and both the 'Music Only' and 'Neither' Groups at the .033/.034 level. The post hoc One Way Anova test for Grade 5 pretest scores was not significant.

Ravens Grades 1/2 Manova Statistics - 73 students

Study Groups	1 Chess Only	26
	2 Music Only	13
	3 Both	18
	4 Neither	16
Gender	1 Male	42
	2 Female	31

Grades 1/2 Increase

		Gender	Mean	Std Deviation	Number
RAVENSPCINC	Chess Only	Male	5.1980	16.66283	19
		Female	12.6802	9.66307	7
		Total	7.2124	15.28964	26
	Music Only	Male	15.5556	18.17270	5
		Female	3.4428	18.78809	8
		Total	8.1015	18.80465	13
	Both	Male	5.2949	16.30456	12
		Female	2.3681	13.95052	6
		Total	4.3193	15.20754	18
	Neither	Male	10.8333	16.62495	6
		Female	7.0556	14.32058	10
		Total	8.4722	14.79003	16
	Total	Male	7.2638	16.50770	42
		Female	6.4861	14.48867	31
		Total	6.9335	15.58182	73

The Ravens Grade 1/2 one-way Manova test is not significant V = .063 F(6, 130) = .703, p = .648. Group and Gender Pairwise comparisons are not significant.

AGAT Grades 3-5 Manova Statistics - 123 students

Study Groups	1 Chess Only	20
	2 Music Only	35
	3 Both	19
	4 Neither	49
Gender	1 Male	75
	2 Female	48

Grades 3-5 Increase

		Gender	Mean	Std Deviation	Number
AGATPCINC	Chess Only	Male	5.9411	10.56849	16
		Female	11.1111	10.10236	4
		Total	6.9751	10.43048	20
	Music Only	Male	7.2418	9.13785	17
		Female	9.8504	10.64141	18
		Total	8.5834	9.88250	35
	Both	Male	9.1863	12.18113	15
		Female	6.1111	8.38870	4
		Total	8.5389	11.34875	19
	Neither	Male	5.9557	10.71817	27
		Female	9.2929	9.64109	22
		Total	7.4540	10.28128	49
	Total	Male	6.8902	10.52330	75
		Female	9.3883	9.73390	48
		Total	7.8651	10.25519	123

The AGAT Grades 3-5 one-way Manova test is not significant V = .044 F(6, 230) = .861, p = .524. Group and Gender Pairwise comparisons are not significant.

All Students Manova Statistics - 203 students

Study Groups	1 Chess Only	46
	2 Music Only	48
	3 Both	37
	4 Neither	72
Gender	1 Male	117
	2 Female	86

All Students Increase

		Gender	Mean	Std Deviation	Number
ALLPCINC	Chess Only	Male	5.5377	14.01458	35
		Female	12.1096	9.34178	11
		Total	7.1092	13.25985	46
	Music Only	Male	9.1313	11.80000	22
		Female	7.8788	13.59914	26
		Total	8.4529	12.68786	48
	Both	Male	7.4568	14.00892	27
		Female	3.8653	11.63243	10
		Total	6.4861	13.34837	37
	Neither	Male	6.8425	11.83955	33
		Female	8.3048	10.40985	39
		Total	7.6346	11.03240	72
	Total	Male	7.0243	12.92258	117
		Female	8.1465	11.47411	86
		Total	7.4997	12.31281	203

The All Students one-way Manova test is not significant V = .012 F(6, 390) = .377, p = .893. Group and Gender Pairwise comparisons are not significant.

The mean for per cent increases of the entire cohort of 203 students was highest among the ‘music’ group, followed by ‘neither’, ‘chess’ and ‘both’. There was no clear pattern in the mean per cent increases for gender differences.

The estimated marginal means for per cent increases of the entire cohort of 203 students showed an inclination for the ‘chess’ and ‘music’ groups to have higher increases, but interestingly it also showed that the ‘both’ group scored significantly below ‘chess’, ‘music’ and ‘neither’.

To add extra rigour to the study, Factorial Anova was used to analyse the results. This is useful to study the effect of two or more independent categorical variables on the dependent variable. The following tables indicate that there is no statistical significance between year level or study groups against the means for test score improvements.

Year Levels:

Multiple Comparisons

Dependent Variable: %CHANGE

LSD

(I) year	(J) year	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	-1.7394	2.85056	.542	-7.3636	3.8848
	3	-6.1389*	2.87230	.034	-11.8060	-.4719
	4	2.2059	2.55725	.389	-2.8396	7.2514
	5	-3.1198	2.75626	.259	-8.5580	2.3183
2	1	1.7394	2.85056	.542	-3.8848	7.3636
	3	-4.3995	2.92985	.135	-10.1801	1.3811
	4	3.9454	2.62173	.134	-1.2273	9.1181
	5	-1.3804	2.81619	.625	-6.9368	4.1760
3	1	6.1389*	2.87230	.034	.4719	11.8060
	2	4.3995	2.92985	.135	-1.3811	10.1801
	4	8.3449*	2.64535	.002	3.1256	13.5642
	5	3.0191	2.83819	.289	-2.5807	8.6189
4	1	-2.2059	2.55725	.389	-7.2514	2.8396
	2	-3.9454	2.62173	.134	-9.1181	1.2273
	3	-8.3449*	2.64535	.002	-13.5642	-3.1256
	5	-5.3257*	2.51887	.036	-10.2955	-.3560
5	1	3.1198	2.75626	.259	-2.3183	8.5580
	2	1.3804	2.81619	.625	-4.1760	6.9368
	3	-3.0191	2.83819	.289	-8.6189	2.5807
	4	5.3257*	2.51887	.036	.3560	10.2955

Based on observed means.

The error term is Mean Square(Error) = 148.044.

*. The mean difference is significant at the .05 level.

Study Groups:

Multiple Comparisons

Dependent Variable: %CHANGE

LSD

(I) intervention	(J) intervention	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
CHESSONLY	MUSICONLY	-1.2495	2.51049	.619	-6.2027	3.7037
	BOTH	.6752	2.68692	.802	-4.6261	5.9765
	NEITHER	-.4325	2.29663	.851	-4.9638	4.0988
MUSICONLY	CHESSONLY	1.2495	2.51049	.619	-3.7037	6.2027
	BOTH	1.9247	2.66184	.471	-3.3272	7.1766
	NEITHER	.8170	2.26725	.719	-3.6563	5.2903
BOTH	CHESSONLY	-.6752	2.68692	.802	-5.9765	4.6261
	MUSICONLY	-1.9247	2.66184	.471	-7.1766	3.3272
	NEITHER	-1.1077	2.46117	.653	-5.9636	3.7482
NEITHER	CHESSONLY	.4325	2.29663	.851	-4.0988	4.9638
	MUSICONLY	-.8170	2.26725	.719	-5.2903	3.6563
	BOTH	1.1077	2.46117	.653	-3.7482	5.9636

Based on observed means.

The error term is Mean Square(Error) = 148.044.

One Way Anova tests were performed on all the variables related to the survey of the 83 ‘chess’ students. The Tukey test for significance was used.

There were no significant correlations between the answers and test scores to the following questions: Gender, First Teacher, Motive Play Chess, Motive Concentrate, Motive Learn, Regularity, Internet, Outside Club, Interschool, Scoresheet, Lunchtime, Private Lessons, QG Rating, Only Lessons, Tuition Company, Home Tuition.

For the following variables, which related to the survey answers given by the chess group of 83, the following correlations were detected:

Chess Coach (The four chess coaches who taught the students chess): The Anova showed that the post-test scores and per cent increases were significant

between the four groups, which were students receiving chess coaching by four different chess coaches, at the .043 level. No post hoc tests were conducted because one of the four chess coaches had only one student.

Gainers (The three groups of students who had high increases and low increases in their chess rating, and those with no chess rating)**:** The Anova showed that pre-test scores were significant at .035 and post-test at .004. The post hoc comparisons showed that the group with low chess ratings increases correlated with the chess group with no rating on pre-test scores at the .037 level.

High Rating: (The three groups of students who had high chess ratings, low ratings, and those with no rating) The Anova showed that pre-test scores were significant at .036, and post-test scores were significant at .001. The post hoc comparisons showed that the chess students with a high rating correlated with the chess group with no rating on post-test scores at the .001 level.

Started Chess (The three groups of chess students who commenced chess this year, last year or before that)**:** The Anova showed that post-test scores were significant at .035. The post hoc comparison between the students who started chess 'last year' and those who started 'before that' correlated on the post-test scores at .039.

Home (The three groups of students who said that they did play chess at home with their family this year, those that didn't and those who did not know)**:** The Anova showed that per cent increases in test scores were significant at .021, but the post hoc comparison showed no significance between variances.

Clock (The three groups of students who said they have used a chess clock, have not used a chess clock or did not know)**:** The Anova showed that post-test scores were significant at .023. The post hoc analysis showed that post-test scores between those who had used a chess clock correlated with those who had not at .028.

Adults and Clocks (The three groups of students who say they have played in a chess tournament with adults and clocks, have not, or don't know)**:** The homogeneity of variance showed a significance of post-test scores based on mean at.038, and the increase in test scores and mean at .030. However, there were no significance in variances in the Anova and post hoc findings.

Choice (The four groups said that if they had the choice they would do more chess, less chess, about the same or don't know)**:** This question asked students if they had a choice would they do more, or less chess. The Anova showed that post-test scores were significant at .019. There was no post hoc test because one group had fewer than two cases.

Parent (The three groups said they chose to play chess, their parents say they must, or don't know)**:** The homogeneity of variance showed a significance of post-test scores based on mean at .016, but the post hoc comparison showed no significance between variances.

5.7 - Discussion

The study shows few statistically valid findings, especially for 'per cent increases'. The pre-test pairwise comparison scores for the 'Both' group and both the 'Music Only' and 'Neither' Groups of the entire cohort of 203 students correlated at the .033/.034 level. However, this was not confirmed by the post hoc analysis. The follow up factorial Anova showed no statistically valid findings in relation to the research question 'Does learning chess affect cognitive thinking scores of Australian grade 1-5 chess students, and what variables, if any, affect the results?'

Whilst the figures for means have not been shown to be statistically valid by the Manova tests, there is, perhaps, a hint from the 'both' group being well below the others. Martinez observed 'the possibility of students' over-involvement in scholastic clubs and extracurricular activities' being a factor in test results, and these findings tend to suggest the same. The figures may tend to show that the 'chess' and

‘music’ groups performed slightly better than the ‘neither’ and ‘both’ groups, but there is no clear pattern.

This researcher proposed that children who just do a weekly chess lesson will not show any improvement in test scores for cognitive thinking over control groups, whereas at some level of extra chess they will.

The correlations indicated a group of strong, keen chess players who received regular private lessons, attended out of school chess club and had high Queensland Junior chess ratings. However only 6 students of the 83 chess students in the study indicated that they were a member of an out of school chess club, only 11 stated that they receive private lessons at home, only 6 had a rating higher than 800 and only 10 gained more than 48 points on the Queensland Junior ratings list during the year. These were all the same students, so the size of the cohort being studied who did a significant level of extra chess was small.

The 83 chess students were surveyed, and the statistics provided have been analysed using one-way Anova.

There was some indication that the choice of chess coach (teacher) was a factor.

There was some indication that having a high Queensland Junior chess rating or having a high increase in the rating could show that these students have higher test scores.

The results seemed show that those who started chess ‘last year’ scored higher than those who started chess ‘before that’. It also appeared to show that those who had used a chess clock scored higher than those who had not. The choice question seemed to indicate that those who would choose to do more chess scored higher than those who would not.

From the results of the Manovas and Anovas, neither the ‘chess’ nor ‘music’ groups are statistically shown to perform better than each other, or the ‘both’ or ‘neither’

groups. What can be stated from the descriptives is that there are indications that both the ‘chess’ and ‘music’ groups seemed to perform slightly better than the ‘both’ and ‘neither’ groups.

Also, that there is a hint that children who try to do too much extra-curricular work (ie chess and music lessons during class time each week) may slightly adversely affect their test scores. There is no statistically significant indication that doing extra chess helps with test scores, although the low number of students who do significant extra chess doesn’t help with statistical validity.

Concerning gender, the researcher found no statistically significant gender differences in the Manovas or Anovas.

The main difference between this study compared with that of Martinez is the attention paid to variables that could influence the results. The Martinez study involved students undertaking one 45-minute social chess group each week with some instruction. A survey measured extra chess at home by time spent and frequency by every day, every other day and every few days.

This study also included a survey which included several questions relating to more advanced out of school chess, chess ratings, chess at home, teacher effect, years playing chess, regularity of playing, representing the school in interschool chess, reasons for doing chess and confounding factors such as home tuition in other school subjects or regularly visiting a tuition company regarding other school subjects.

Whilst many believe that learning to play chess has cognitive benefits, it is becoming increasingly apparent that it probably does not, and this study concurs. The null hypothesis in this study is probably correct. In their paper ‘Cognitive Training Does Not Enhance General Cognition’, two eminent researchers in the field Sala and Gobet (2018) argue that ‘practicing cognitive-training programs or intellectually demanding activities do not enhance general cognitive ability or any cognitive skill. At best, such interventions boost one’s performance in tasks similar to the trained task.’

Chapter 6 – Conclusion

The design of this study included 83 students who received a half-hour, weekly chess lesson which replaced a normal curriculum lesson. The type of lesson varied from child to child, and sometimes between term to term. Eminent researchers in the field of chess and education, Sala and Gobet, in their study 'Far Transfer: Does it Exist' (2017) argued that it probably does not.

> 'If the aim is to teach mathematics, lessons focussing on mathematics are better than lessons containing material on music, chess or working memory training'.

The researcher believes he has witnessed various stages that chess players go through. There appears to be a significant range of time differences between children for progressing through these stages. Themes studied by chess players, which the researcher regards as one way of defining stages that chess players go through, include:

1. Learn how to move the pieces
2. Learn how to take and protect pieces
3. Learn how to checkmate
4. Learn various tactics (tricks)
5. Learn how to make plans
6. Learn how to consider the plans of the opponent
7. Learn opening theory
8. Learn to become a strategic thinker

Somewhere between items 4 and 6, most students would be getting to a Queensland Junior rating of 800+. Very occasionally a 7-year-old child reaches this rating within 12 months of taking up chess. Some students may take several years. The researcher has observed that most students take at least 3 years to achieve this rating. When children get to stage 6 or 7, they seem to become much better all-round thinkers. Strong senior chess players well into their teens, will happily debate with an 8-year-old the moves that have been played based entirely upon academic merit, rather than age. In serious junior chess competitions, this is not unusual.

Piaget's Theory of Stages in Cognitive Development shows pre-operational stage ages 2-7, concrete operational stage ages 7-11 and formal operations stage 11-15. History tells us that chess players have become Grandmasters as young as 12 years old. Some students move through the stages more quickly than others.

The researcher is interested in the sudden learning spurts in primary school students. When he was teaching a lower primary student a very basic idea it wasn't grasped after many weeks, whereas the other students in this grade had. This was mentioned to the teacher and he said look at it this way 'the lights haven't come on yet.' When the researcher reflects upon all of the many students he has seen progress up the ratings list, a common theme is that there seems to be a culmination of learning where the student seems to 'get it', and a sustained surge in playing strength then occurs in the next 1-2 years, measured by their rating. This happens anything from 1-7 years after the child starts learning chess.

The researcher has often commented to other coaches or parents that students need to take more time over their moves, but they fail to do so in response to their coach or their parent. It seems it must come from the child, often after many painful defeats. The moment that the child finally considers the chess positions more carefully seems to coincide with a sustained surge in playing strength as measured by the ratings list.

Some students seem to go through a stage of being highly motivated to get better at chess. They are constantly seeking more information and enter as many chess tournaments as they can. They can't wait for the next ratings list to be published to see if, and by how much, their chess rating has gone up. It is not hard to identify these students. However, there often seems to be a time lag between a lot of learning going on, and an improvement in results, leading to a jump in the child's rating.

It is hypothesised that the child is receiving a whole lot of new information with various tactical, strategic, rote learning and pattern recognition themes being taught and learned. It is likely that the delay in ratings jump is due to the synthesising of new ideas going on in the child's mind. The researcher believes that it is essential for

children to play regular games of chess to facilitate the necessary synthesis of ideas learned.

An issue is at what stage of a child's learning of chess do they start to gain transfer of thinking between domains? Or do they not gain any transfer at all? The researcher believes that this differs from child to child and that it is possible that different skills kick in at different stages of chess development. Perhaps practising chess accelerates the process. Perhaps not.

This is one of several reasons why a longitudinal study would be useful. The qualitative part of a mixed methods study would enable meaning to be gained from qualitative tools such as interviews, small groups or surveys. Why do some students gain a chess rating, and then not improve it, or improve it very slowly, while others shoot up? Why do some students seem to be very keen, study a lot, enter lots of tournaments, stay on the same rating for quite a while before suddenly leaping up? Do students who move quickly up to the top of the rankings do well academically?

Australian Grandmasters noted earlier in this review that they use a substantial list of thinking skills when they play long games of chess. Logically, when they were very young they had very few, but their skills have steadily developed until they achieved Grandmaster status. This can happen in as little as 7 or 8 years (as previously mentioned, the earliest age that a child achieved the Grandmaster title was 12).

Several questions arise.

> At what age (or playing strength) do they acquire each of the thinking skills on the list? Is there a big discrepancy between them?
>
> Do they acquire all, or some of them, faster than non-chess players?
>
> Do they acquire all, or some of them, faster than non-chess players who are of similar academic standard?

Personal observation over many years in chess show that young chess players who are complete beginners are very quick to pick up new ideas relating to tactics. A tactic is a chess move (trick) which gains an immediate (next move or two) material

advantage. The simple idea is that by playing the tactic, they will then have more pieces (material) than their opponent.

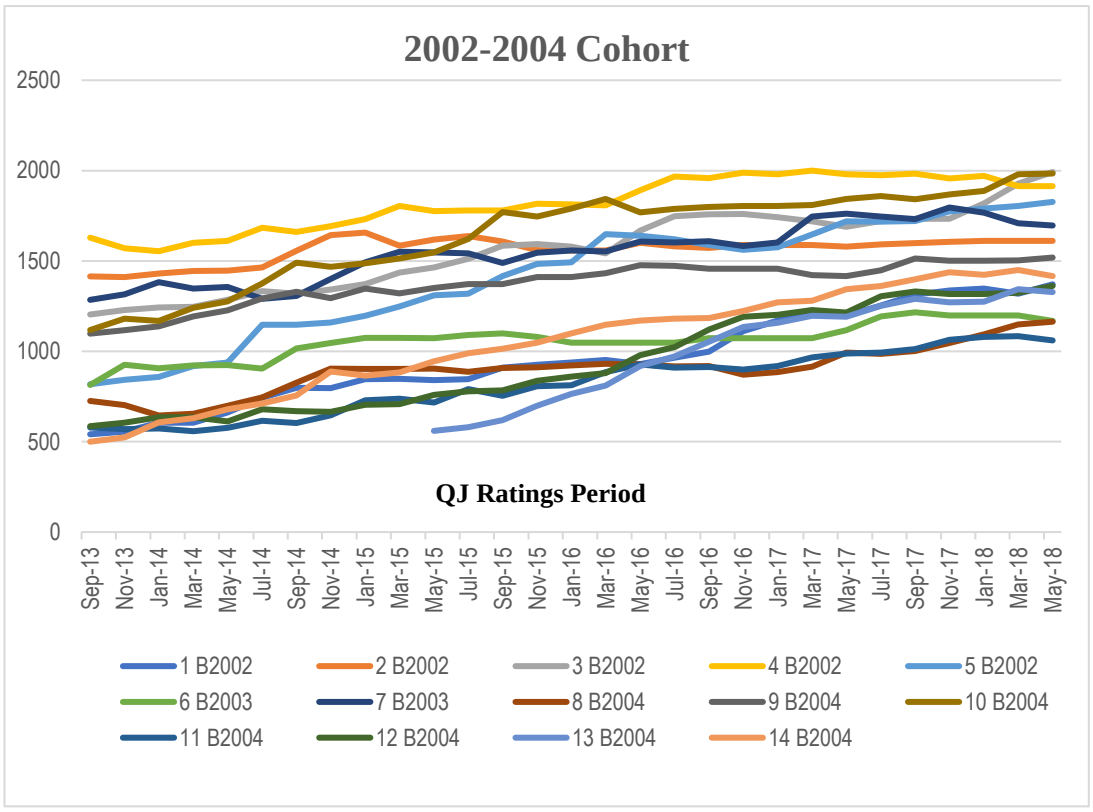
By contrast, students just beginning chess would usually not consider strategy until they have had considerable experience. Strategy in chess involves such concepts as space, time and pawn structure. A chess player who is thinking strategically is taking a long-term view of the game. For example, will their plan lead to an opportunity to penetrate with rooks along the c file, or will they be able to mount a pawn storm on the king's side, or are they aiming to simplify the position into a pawn ending where they will have a superior pawn structure? It seems normal for students to take a few years of learning chess to grasp the idea of strategic thinking.

If there is a big difference in the time taken to understand tactical and strategic thinking ideas, then it is likely that other thinking skills such as critical, creative, cognitive and logical, together with the whole Grandmaster's list, will also kick in at different stages. Piaget's theory of stages of development of cognitive thinking would seem to concur.

In the researcher's experience, chess students reach a stage where they have synthesised a whole lot of ideas that they have been taught and can be put into practice in tournament chess at a higher and higher level. This can be measured by the Queensland Junior ratings list. Perhaps the sudden spurts in chess playing ability, if they exist, (measured in this case by the Queensland Junior Ratings List), happen at a significant range of different ages and year levels.

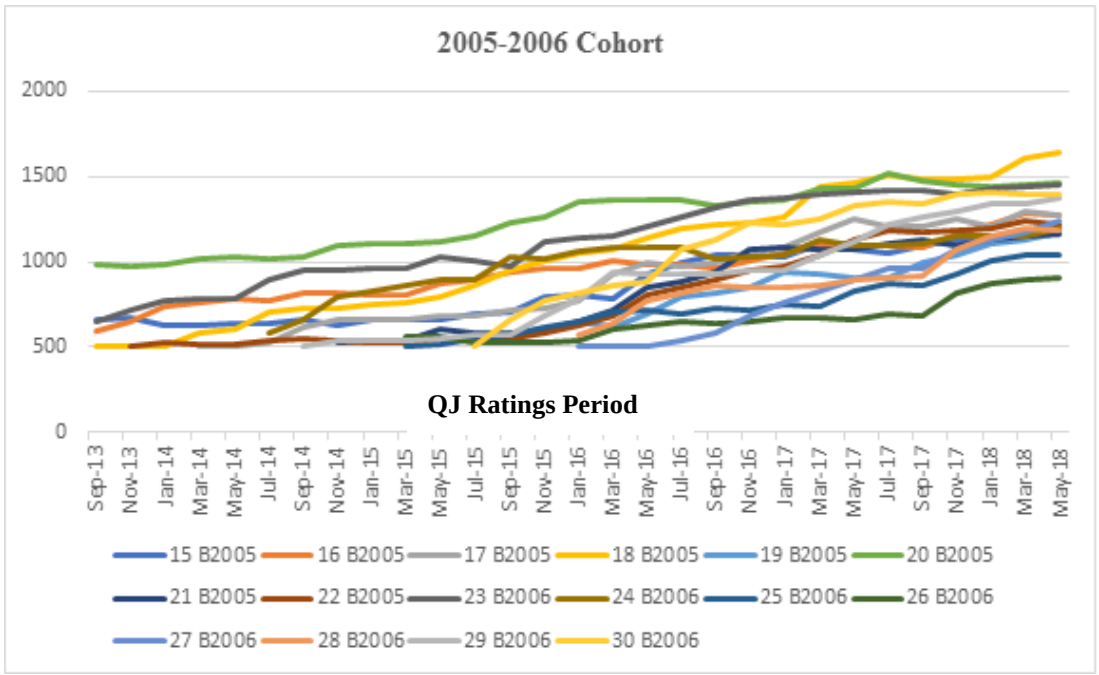
To demonstrate the idea of sudden spurts in chess playing ability, the researcher identified the top 40 players in the current Queensland Junior Ratings List and went back five years to map the progress of each junior on the two-monthly lists (see Figures 4 to 8). These charts indicate that children's chess ratings tend to progress in spurts.

Figure 4 – Student Rating Progress



Student # with year of birth

Figure 5 - Student Rating Progress



Student # with year of birth

Figure 6 - Student Rating Progress

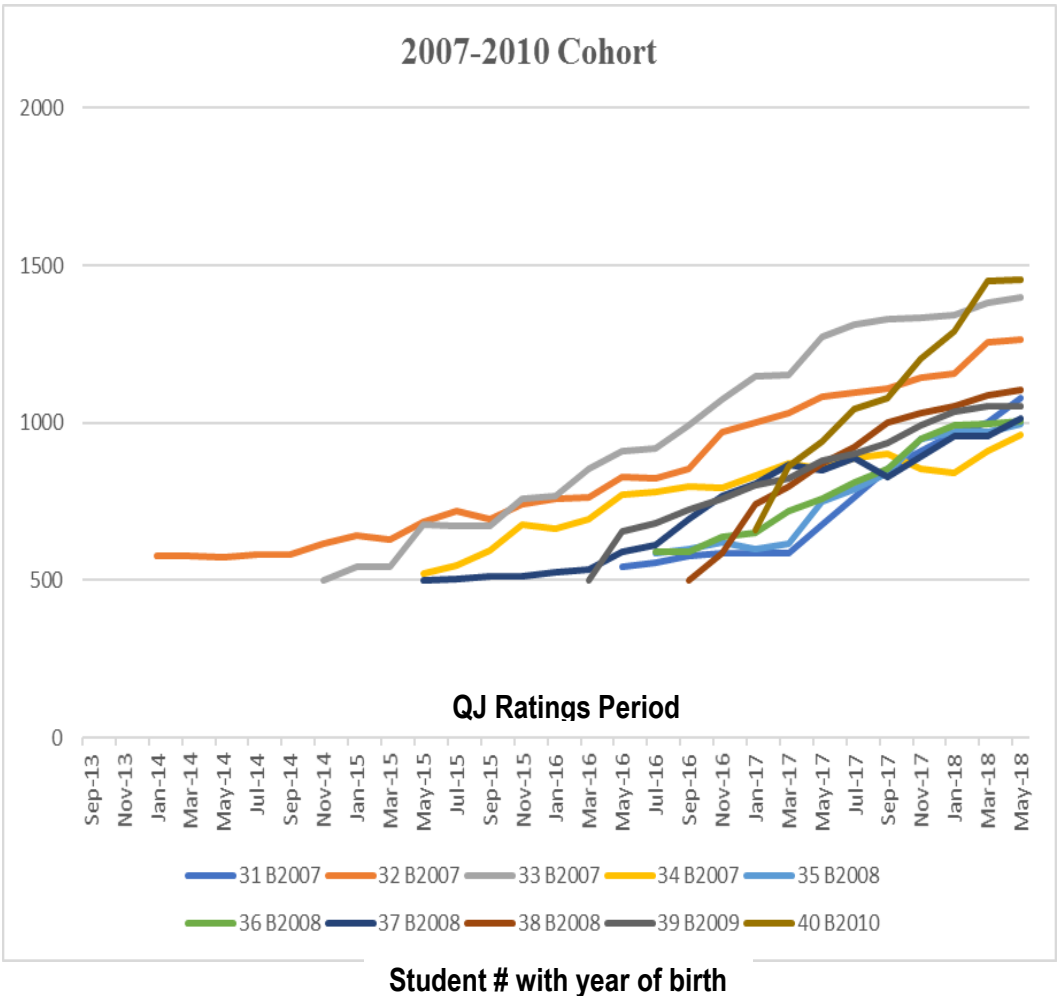


Figure 7

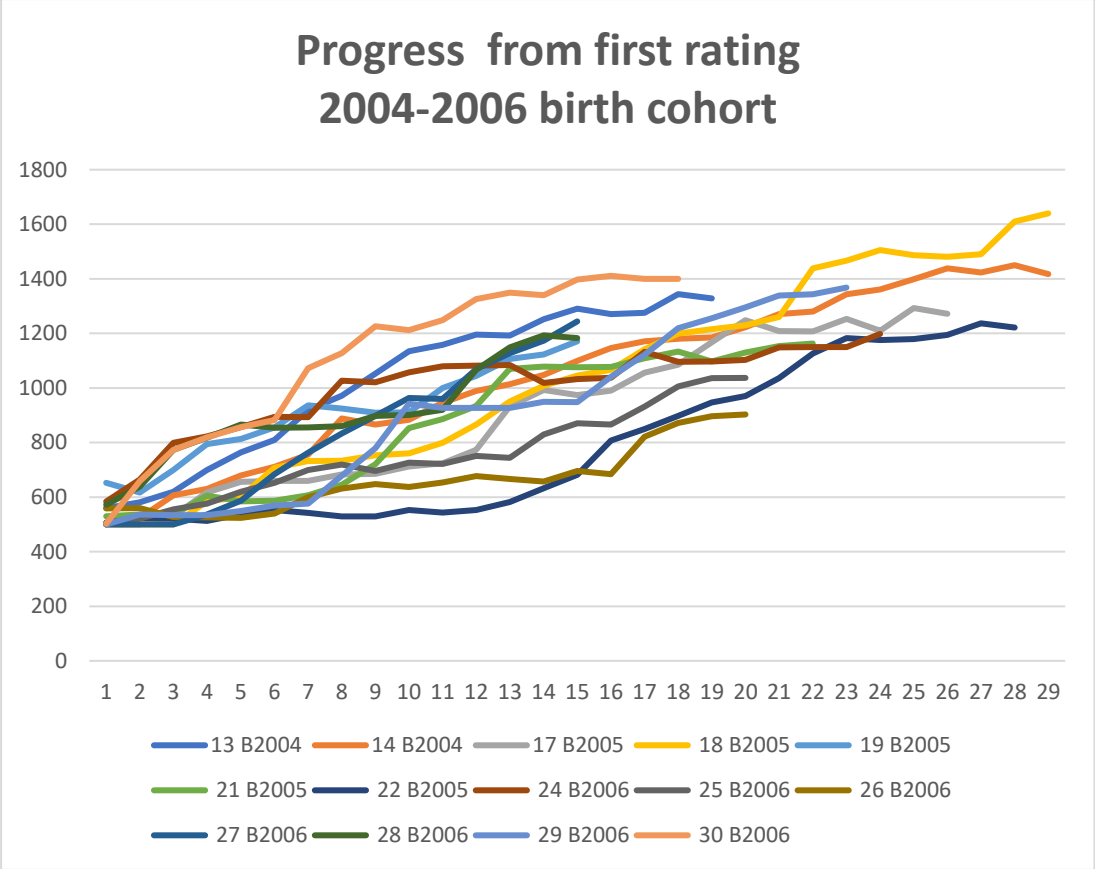
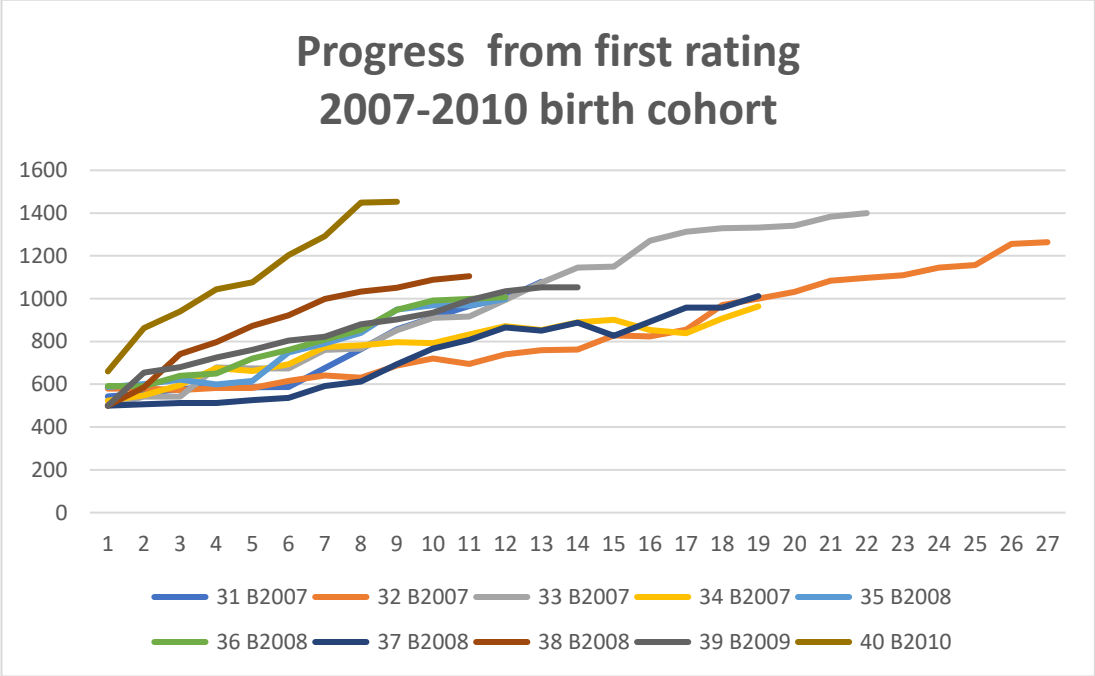


Figure 8



It is quite possible that Grandmasters reach the Grandmaster standard after several years of practice, but with perhaps only three or four identifiable bursts of improvement, each coinciding with when the brain has fully synthesised a new and more advanced set of themes. Perhaps it is at these stages that there is a transfer of skills to other domain(s). These could, for example, include critical, creative or strategic thinking skills. Transfer of skills would be hard to measure using current models of research, because they haven't normally followed a cohort child by child as individuals over a period of years.

The researcher has also witnessed the ratings of a junior falling for a short while whilst that junior is learning new themes. There seems to be a point where the junior involved is struggling to adopt the new ideas and plays a hybrid version which is less effective. Chess coaches will often say that they can see that their student is learning plenty, but it will take a little time to reflect in their results and hence their rating.

Some studies in the literature review have indicated modest improvement in test scores for chess students versus control groups, whilst others have shown no such improvement. Researchers seem to agree that it is difficult to achieve transfer of skills from one domain to another.

The latest research into chess and thinking skills is critical of previous research in the field.

> 'In much of the existing literature, we find hardly any evidence of effect of chess instruction upon children's mathematics, reading or science test scores. The results of this research provide a timely reminder of the need for social scientists to employ robust research designs.' (Jerrim et al, 2017).

In the survey conducted in this study, out of 315 people in the chess community, 300 felt learning chess helped children with their cognitive, critical, creative thinking and problem-solving skills. This group included 52 school principals, 109 parents of children who were learning chess and 52 school teacher chess coordinators. Why is it that so many serious adult chess players believe that learning chess has helped them to become better thinkers? (personal conversations between adult chess players and the researcher).

One reason could be that studies involving chess and cognitive thinking have tended to focus on relative beginner players, mainly in primary schools. Upon reflection, thinking about his involvement in chess, the researcher believes it is quite possible that if transfer of skills does occur, it does not do so until the chess player has gone beyond the beginner standard.

The study on developing critical and creative thinking through chess supports the researcher's viewpoint as the senior school students who gained significant chess skills also excelled in the Pennsylvania State Scholastic Championship. Moreover, the specially chosen senior school chess group performed significantly better than the non-chess group by a considerable margin. (Ferguson, 1986). This research indicates that perhaps significant improvement does not happen until chess players reach a high level, or at least a reasonably high level for junior school students.

The researcher believes that to determine if learning chess over time improves cognitive thinking, a cohort of participants is required that includes a significant number of students who are going through the stage where they have gained or are gaining significant improvement in chess skills as measured by the Queensland Junior ratings list or some other statistically valid list. This group needs to be followed individually, child by child, to measure whether 'spurts' of chess improvement coincide with high improvements in test scores.

There is also the question of whether the students going through the stage of strong chess development are improving their cognitive thinking skills, alternatively their critical thinking skills, or both. Indicators such as learning how to combine making one's plans, considering the plans of one's opponent and considering a strategy for the remainder of the game can reflect an advanced level of critical thinking. There is strategy in chess, and not much work has been done in relating learning chess with improvements in strategic thinking skills.

In her paper related to strategic thinking and whether it can be taught, Liedtka (1998) p124 made an interesting observation:

> ‘The Outcomes of Strategic Thinking Firms who succeed at embedding a capability for strategic thinking throughout their organizations will have created a powerful new source of competitive advantage….A capacity for hypothesis generation and testing will incorporate both creative and critical thinking into their processes….Taken together, these elements create a capacity for strategic thinking that meets the three fundamental tests for a strategically valuable capability: (1) they create superior value for customers, (2) they are hard for competitors to imitate, and (3) they make the organization more adaptable to change.’

This links creative thinking and critical thinking with strategic thinking. There are valid tests for both critical and creative thinking available, but to date no valid tests for strategic thinking have been found in this study. Nevertheless, this perhaps gives a good hint that a useful study could be conducted involving students learning to play chess and their critical, creative and strategic thinking skills.

Earlier in this paper McGregor (p246) argued that ‘in problem-solving situations, there is much critical thinking. More creative thinking is needed when possible tactics, methods or approaches to the problem are developed and proposed’. The constant weighing up and synthesising of ideas can lead to more innovative ideas….’

In their paper, Use of Chess in Military Education, Kende and Seres (2006) discuss numerous incidents where chess has been used to strategise in war. The Science of Tactics (p. 23.); The Restriction of the Movement of Military Force (p. 48), Initiative and Attack (p. 72.); Disruption of Balance (p.109); Active Defence (p. 185.); Attitude and Conduct of War (p.217); Cooperation of Combat Units (p. 288.); Planning and Executing Military Operations (p. 315.).

Similarly, a study comparing chess and non-chess players found that chess players outperformed non-chess players on planning tasks and the performance of chess players increased with more difficult problems (Unterrainer et. al, 2006).

The researcher believes that students do not start to properly strategise in a game of chess until they have been playing for some years. A study in this field would be a difficult task, but it is quite logical that playing chess helps strategic thinking.

In addition to cognitive, critical, creative and strategic thinking, other areas of chess thinking that could be looked at include logical thinking and problem-solving skills.

With the relatively high incidence of children with autism and/or ADHD, this researcher believes that significant research in this field is warranted, with the aim of reducing the number on medication and increasing the self-esteem of many. The Blasco-Fontecilla et al (2016) and El Daou et al (2015) studies were both considered promising.

There appear to be numerous opportunities, and need, for further studies in the field of chess and education.

Table 16: The Survey Questions used in the Statistical Analysis

When did you first learn chess?	STARTEDCHESS	1 = This Year; 2 = Last Year; 3 = Before That; 4 = Not Sure
Who first taught you chess?	FIRSTTEACHER	1 = Family Member; 2 = Somerset College Chess Teacher; 3 = Other
Regarding playing chess, do you think it is?	MOTIVEPLAYCHESS	1 = Great; 2 = Just ok; 3 = Not Enjoyable; 4 = Not Sure
Do you think learning chess helps you to concentrate better in class?	MOTIVECONCENTRATE	1 = Yes; 2 = No; 3 = Don't Know
Do you learn chess at Somerset College mainly because?	MOTIVELEARNCHESS	1 = It's Fun; 2 = Helps with School Work; 3 = Make Better Thinker; 4 = Parents Say You Must; 5 = Not Sure
Do you learn, practice or play chess?	REGULARITY	1 = Most Days; 2 = Some Days; 3 = Once a Week; 4 = Don't Know
Have you played regular chess at home with your family this year?	HOME	1 = Yes; 2 = No; 3 = Don't Know
Do you play regular chess at home on the internet?	INTERNET	1 = Yes; 2 = No; 3 = Don't Know
Are you a member of an out of school chess club?	OUTSIDECLUB	1 = Yes; 2 = No; 3 = Don't Know
Have you represented Somerset College in an inter-school chess competition this year?	INTERSCHOOL	1 = Yes; 2 = No; 3 = Don't Know
Have you ever used a chess clock?	CLOCK	1 = Yes; 2 = No; 3 = Don't Know
Have you played in any chess tournaments involving adults and clocks this year?	ADULTSCLOCKS	1 = Yes; 2 = No; 3 = Don't Know
Do you know how to keep a scoresheet in a game of chess?	SCORESHEET	1 = Yes; 2 = No; 3 = Don't Know
Do you do any extra chess at Somerset College each week (eg., lunchtime chess club, casual chess games in the library)?	LUNCHTIME	1 = Yes; 2 = No; 3 = Don't Know
Do you have regular extra chess coaching at your home from a private chess coach?	PRIVATELESSONS	1 = Yes; 2 = No; 3 = Don't Know
Do you have a Queensland Junior chess rating?	QJRATING	1 = Yes; 2 = No; 3 = Don't Know
Is your regular co-curricular chess lesson at Somerset College the only chess you do each week?	ONLYLESSONS	1 = Yes; 2 = No; 3 = Don't Know

If you had a choice, would you do?	CHOICE	1 = More Chess; 2 = Less Chess; 3 = About the Same; 4 = Not Sure
Do you enjoy your regular co-curricular chess lessons at Somerset College?	TEACHER	1 = Yes; 2 = No; 3 = Don't Know
Do you learn chess at Somerset College each week because you really want to, or because your parents say you must?	PARENT	1 = You want to; 2 = Parents say you must; 3 = Don't Know
Regarding extra learning for other things like maths and English (not chess), have you been regularly attending a company like Kumon, Kip McGrath, North Shore or James An?	TUITIONCOMPANY	1 = Yes; 2 = No; 3 = Don't Know
Regarding receiving regular home tutoring for other things like Maths and English (not chess), has a home tutor been teaching you?	HOMETUITION	1 = Yes; 2 = No; 3 = Don't Know

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Appendix

1 - Student Survey Comments

Is there anything else you would like to say about your Involvement in Receiving Chess Coaching at Somerset College?

Year 1

- I really like it and I'm never going to stop it.
- It's great.
- Chess is fun and makes me happy. We play chess at home because I learn it from school. My brother taught me the chess first.
- I love it.
- Play Chesskid. Dad teaches me chess. Played chess last year in Prep during Discovery Time.
- Playing chess makes your brain work hard. Mum borrowed a book from the library about chess.
- (CW) His dad helps him with his school work. Dad teaches (name redacted) chess. Chess is fun.
- (CW) (Name redacted) used to go to Chinese School. she plays chess because her mother wants her to.
- Extra coaching in Maths is in Russian.
- I love it a lot.
- I Ike it, when it is, where it is.
- I love chess.

Year 2

- It's really good.
- (Name of coach) is a very good teacher and if I didn't have him I wouldn't have won so many ribbons and medals.
- I have private lessons before school on a Monday at 7 o'clock. They are both good coaches.
- It helps you concentrate because it helps you working better to concentrate.
- I really like it because you get to make new friends.
- CW - (Name redacted) gets occupational therapy help for her writing and drawing.
- It's really good.
- The chess is the best in the world.
- I love chess lessons so much.
- Maybe you should have more time at our chess lessons.

Year 3

- It's great, it's fun, I like to play chess all the time.
- It's really fun
- That I really want to learn more about chess.

Year 4

- (Name redacted) doesn't participate in co-curricular lessons at Somerset College because his parents don't want him to.
- CW - he used to go to the Mudgeeraba Chess club last year. He used to have coaching with James An a couple of years ago.
- I have a tutor who comes when I need to make things for school. She brings the materials. She helps me make something if it's hard. I used to go to Tuesday chess club earlier this year in Term 1. I've to a lot of interns hoop, we won twice in the girls but this year we came 5th or 6 th, I can't remember. My coach is nice and always gives me overtime because he says

you can't learn much in 30 minutes.

- I think that a lot of students should enrol in chess because it's a lot of fun.
- It's a great opportunity to learn strategy and focus.
- It really helps because chess is interesting and it is a fun thing to do.
- (Name of coach) comes to my house for chess coaching in the holidays. I just love chess.
- I think it's a great way of learning, it makes you concentrate better.
- I think it's really good and it really helps me learn.
- It's good. It's really fun.
- CW - he plays chess sometimes with a friend at home.
- I think chess is helpful, because at the tournaments you have to sit there for like an hour and concentrate. If you're a really good chess player you're usually good at academics. It is fun because the chess coaches are funny and helpful.
- I've learnt more about chess since the beginning.

Year 5

- It's been really fun playing chess.
- It's fun.
- It's great. CW - goes to Chinese school.
- I used to go to James An.
- Thank you for helping me to learn to play chess.
- I get some coaching for school at home sometimes.
- Chess builds my concentration, helps me to relax, helps with things out of school - I think before I make choices in life and say things. I think everybody should have a go at playing chess as it helps you to make choices. It helps you outside chess. I strongly advise you to play chess. It is a really fun game.

- Play chess on the computer and iPad, Chess.com and Chess Base.
- Some of the kids don't take the chess coaching seriously and because they're naughty they get me caught up in it.

2 - Definition of Terms

Transform missing values - Imputation preserves all cases by replacing missing data with an estimated value based on other available information.

Series mean - The arithmetic mean, also called the average, of a series of quantities is obtained by finding the sum of the quantities and dividing it by the number of quantities.

Skewness - Asymmetry in a statistical distribution, in which the curve appears distorted or skewed either to the left or to the right. Skewness can be quantified to define the extent to which a distribution differs from a normal distribution.

Kurtosis - the sharpness of the peak of a frequency-distribution curve. It is a measure of whether the data are heavy-tailed or light-tailed relative to a normal distribution.

Standard error - a measure of the statistical accuracy of an estimate, equal to the standard deviation of the theoretical distribution of a large population of such estimates.

Communalities - The sum of the squared factor loadings for all factors for a given variable (row) is the variance in that variable accounted for by all the factors, and this is called the communality.

Principal Component Analysis - a method of analysis which involves finding the linear combination of a set of variables that has maximum variance and removing its effect, repeating this successively.

Correlations - a common statistical analysis, usually abbreviated as r, that measures the degree of relationship between pairs of interval variables in a sample. The range of correlation is from -1.00 to zero to +1.00.

P (probability) values - the chance that a phenomenon will occur randomly. As a statistical measure, it is shown as p [the "p" factor].

Factor Analysis - a statistical test that explores relationships among data. The test explores which variables in a data set are most related to each other.

Reliability - the degree to which a measure yields consistent results

Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) - is a measure of how suited one's data is for Factor Analysis. The test measures sampling adequacy for each variable in the model and for the complete model. The statistic is a measure of the proportion of variance among variables that might be common variance.

Rotated Component Matrix - is the key output of principal components analysis. It contains estimates of the correlations between each of the variables and the estimated components.

Varimax with Kaiser normalisation – Varimax Describes a rotation that maximizes the sum of the variances of the squared loadings. Kaiser suggested normalizing factor loadings before rotating them, and then denormalising them after rotation

Cluster Analysis - a method of statistical analysis where data that share a common trait are grouped together.

Frequency - the rate at which something occurs over a particular period of time or in a given sample.

ANOVA and MANOVA (V, F and p) - ANOVA tests for the difference in means between two or more groups, while MANOVA tests for the difference in two or more vectors of means.

Mean - the mean or average that is used to derive the central tendency of the data in question. It is determined by adding all the data points in a population and then dividing the total by the number of points.
Standard Deviation - a measure of variation that indicates the typical distance between the scores of a distribution and the mean; it is determined by taking the square root of the average of the squared deviations in a given distribution.

Post Hoc - occurring or done after the event, especially with reference to the fallacious assumption that the occurrence in question has a logical relationship with the event it follows.

Variable - any characteristic or trait that can vary from one person to another [race, gender, academic major] or for one person over time [age, political beliefs]

Homogeneity of Variance - The assumption of homogeneity of variance is that the variance within each of the populations is equal. This is an assumption of analysis of variance (ANOVA).
Significance

Estimated Marginal Means - refers to the unweighted means when comparing across different sample sizes by accounting for each mean in proportion to its sample size.

Reliability Coefficient - a measure of the accuracy of a test or measuring instrument obtained by measuring the same individuals twice and computing the correlation of the two sets of measures.

3 - Random Draw for respondents to the survey

This researcher's supervisor, Dr Luke Van Der Laan, kindly organised to use a random draw programme to conduct the draw. It was conducted in his office at USQ in Toowoomba on Thursday 10th March 2016. The winner of the beautiful wooden chess set was **Mrs Elizabeth Graham**, who has been the successful chess coordinator at St Francis Xavier Catholic Primary School, Runaway Bay for many years.