The effect of playing chess on the mathematics achievement of Primary School learners in two schools in KZN

By

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ABSTRACT

The purpose of this study was to find out whether there was a relationship between playing chess and learners' achievement at Mathematics. To investigate the relationship an *ex post facto, quasi-experimental* research design was used. Learners from two Senior Primary Schools in Kwazulu-Natal who had active school chess clubs were selected to participate in the study. The learners' average mathematics marks at entry year to their Senior Primary Schools were considered the pre-test data. These marks were compared to their mathematics marks at their current grade that was considered the post-test data. In addition a further analysis was done with a group of chess players and a carefully selected group of matched non-players using mathematics marks at entry year as the matching criteria. In all cases the treatment was considered to be the current active participation in chess. The data and background information about the groups was obtained from teachers' interviews, existing school records and a questionnaire that was completed by the participating learners.

It was found that for the chess players (the test group) the improvement in the average mathematics mark at Grade 7 (post-test) compared to their entry year average mathematics mark (pre-test) was significantly higher than that of non-players. While the chess players' marks improved, the non-players marks (control group) declined. This finding was further supported by analysis of the matched pairs where the same trend was found. Statistical analysis using t-test found that the results were significant. Further detailed analysis of sub groups within the data revealed that current chess players who were below grade average at Grade 4 had improved their mathematical

achievement by even more compared to their matched non-players, at Grades 5, 6, and 7. This points to a possible positive causal effect between chess and mathematics achievement for below average achievers.
When the amount of exposure to chess was investigated, no correlation was found between the amount of chess played (frequency and length of time) and the level of improvement in mathematical achievement. However, playing chess for a period longer than six months, did positively affect the mathematical achievement of Grade 7 active chess players and the mathematical achievement of the weaker learners at all Grades for which data was collected in the study.

This study implies that the incorporation of chess into school activity and further encouragement for all learners to play the game should be seriously considered by the education authorities since it is likely to result in the overall improvement of the mathematical achievements especially in the higher grade of the Senior Primary School.

PREFACE

The work described in this thesis was carried out in the School of Education, Durban, University of Kwazulu-Natal, from July 2003 to April 2004 under the supervision of Dr Paul Hobden (Supervisor).

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any tertiary institution. Where use has been made of the work of others, it is duly acknowledged in the text.

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CHAPTER 1

INTRODUCTION

1.1 PREAMBLE

As an enthusiastic chess player since my Primary School days, I passed my love of the game to my sons. They played chess throughout their school years at provincial, national and international tournaments, each one of them in his pace, gradually withdrawing from competitive playing as other interests took over. Following closely their 'chess careers' and getting to know their friends, reinforced my observations done years back, while I myself played chess, that most of the chess players were above average achievers. Is it a coincidence? Do only above average learners choose to play chess? Or is playing the game contributing to the improvement of learning abilities and thus to learners' achievements.

The draft revised National Curriculum Statement presents the kind of learner envisaged to emerge from the new curriculum. Among others, the expected characteristics of the learner are to "Use effectively a variety of problem-solving techniques that reflect different ways of thinking, recognising that problem-solving contexts do not exist in isolation" (Department of Education, 2001: 13). The development of a learner who is capable of thinking critically, solving problems related to his academic work as well as his future functioning in society, are key objectives. This suggests that tools / topics /mechanisms identified as helpful in meeting these objectives, should be embedded in the new Curriculum. Can teaching and playing chess be one of them? If learners who played chess show improvement compared to learners who did not play, a serious consideration should be given to conscious encouragement of learners to learn and play chess and to the introduction of chess into the school curriculum.

Chess is a game of the mind. In addition to learning the rules, the player needs to plan, concentrate and get out of difficult positions by critically analyzing the various options and make the right decision. Several studies in the area of 'Chess in Education' were conducted over the last thirty years and provided evidence that playing chess enhanced creativity, reading, concentration, critical thinking skills, memory, problem solving, IQ and academic achievements (Christiaen, 1976; Ferguson, 1995; Krogius & Gershunski, 1987; Margulies, 1991; Van Zyl, 1991).

The ability to formulate, represent and solve mathematical problems (strategic competency) as well as the capacity for logical thought, reflection and explanation (adaptive reasoning) can be matched to some of the proficiencies required to become a chess player. By learning and playing the game, a chess player will develop, among other proficiencies, chess related strategic competency and reasoning. The player will develop the abilities to think in structured and logical ways to plan and to solve chess problems as well as to explain the reasoning behind his actions.

The question remains as to whether these skills, acquired through playing the game, are transferable despite chess being somehow remote to mathematics; are learners who play chess, developing proficiencies which are impacting positively on their mathematical achievement through transfer of skills common to mathematics and chess? This study intended to find out whether learners who learnt to play chess, and played the game for several years, consequently achieved better in Mathematics.

1.2 RESEARCH APPROACH

Aiming to find out whether there is a correlation and cause-effect relationship between chess and mathematics achievement, this research was designed as a small-scale study using learners' mathematics marks as an indicator of their achievement in mathematics. The questions posed were: does playing chess improve players' mathematics achievement and is there a correlation between mathematical achievement and the level of exposure to the game? Two schools within the larger Durban area (eThekwini Municipality) were chosen to participate in the study. The first school was a multiracial, well-resourced government school, in an upper middle class area. The second school was an under resourced school, situated in a low-income area in a local township. Both schools were known to have active chess clubs, operating as extra curriculum activity. From each school, learners were selected for the test and control groups. The learners selected for the test group, were active chess players at the start of study and have been playing chess for at least six months. For most chess players, a matching non-player was selected to build-up the control group.

A 'quasi-experimental' research was conducted, since random assignment of schools or learners did not take place. "Often in educational research, it is simply not possible for investigators to undertake true experiments………………..or randomization of exposure – essential if true experimentation is to take place" (Cohen et al., 2000: 214). The research was done as *ex post facto*, based on:

- *Teachers' interview* that provided lists of active chess players and further general information about their schools and learners.
- *School records* of mathematics achievement (marks) of learners who played chess and their matched non-players.
- and a *Questionnaire* which was completed by all learners who participated in the study, to confirm their status as players or non-players, to determine the length/magnitude of their exposure to the game and to obtain further qualitative information about their habits, perceptions and attitudes towards the game.

The quantitative data was obtained by measuring and analysing changes in mathematics achievements for the chess players. The qualitative data was obtained through the analysis of learners' responses about their playing habits, their attitudes towards the game and the possible contribution of the game to their academic performance.

1.3 STRUCTURE

Following this introduction, which aimed to acquaint the reader with the motivation and background to the study, this dissertation includes: literature review - linking the theoretical background to local and international research already done in areas related to this study - chapter 2, research methodology - describing in detail the reasoning behind the way this research was conducted as well as the process of data collection, challenges faced and concessions made - chapter 3, review of results, their analysis and interpretation - chapter 4 and conclusion that includes a summary of the main findings and recommendation for future research - chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter aims to present an in-depth critical review of existing academic research done in the area of chess and its relationship to mathematics, with-in the broader area of chess and education. A critical question for the review is to whether the development of skills such as reasoning and creativity (skills required to play chess) in one context transfer to a different context (such as mathematics), resulting in improved mathematical achievement.

The first part of the review focuses on the game of chess, the characteristics and proficiencies developed through learning and playing this game. The major part of the review deals with literature on studies done internationally in both developing and developed countries as only limited research was done in South Africa. This is followed by reviewing research into the field of mathematics education, and skills identified as essential for learners to have, in order for them to be able to be successful at mathematics. Identifying skills common to both chess and mathematics and the theories around transferability of skills, followed by differences and similarities between these studies and this research, concluded this review.

2.2 CHESS

> In their grave corner, the players
> Move their plodding pieces. The board
> Detains them until dawn within its
> Strictured bounds where two colours clash (Borges cited in Neville, 1989: 651).

2.2.1 <u>What is Chess?</u>

Chess is a board game believed to originate in India, in the 6th century. In its modern version, as it is played today, the game is about 500 years old. The game has strict yet simple rules. Played by two players who face each other on the opposing sides of the board – they play to win. In order to win, a player has to trap their opponent's King by thought out placing of their pieces on the board. Each of the pieces has its own defined moves that determine its usage (power). A player needs to learn to plan their game and at times maneuver themselves out of difficult situations – this is conducive to producing creative solutions within time constrains. A player can study conventional moves and games, played by others in order to avoid having to reinvent solutions in common situations. This is a basic description of the characteristics and abilities required from a chess player.

"Is chess an art? A science? Some claim it's both. Yet let's be honest, it's really just a game. Fun, challenging, creative; but still a game…."(Dauvergne, 2000: 2). He argues that chess is a tool to develop children's minds affecting broadly their mental performance since "they must analyze and calculate, relying on general principles and patterns along with those of creativity and originality – a skill that increasingly mirrors what students must confront in their everyday schoolwork" (Dauvergne, 2000: 6).

2.2.2 Skills developed and used in Chess

Over the last three decades, several chess related experimental studies were conducted in various parts of the world. While some were interested in identifying skills required to become a good chess player aiming to identify the potentially good players, an increasing number of studies aimed to identify skills developed by playing the game.

The former USSR has been the world's leading state in Chess since the 1950's. Unfortunately, only a limited number of published studies have been translated. However, Russian scientists came to the conclusion that chess could possibly contribute outside its 'game' boundaries.

> We would like to emphasize that, side by side with the thesis 'chess is a science', the thesis 'chess for science' also deserves increasing recognition. In other words, the study of that which chess can give to various branches of knowledge is becoming increasingly important (Gashunski, 1987: 3).

Some of the more recent studies, took place in the USA and Canada, and were published in (or translated to) English. Ferguson (1995) published comprehensive reviews on the topic of chess education with his emphasis on the role of chess in education. While touching on the skills required for high achievement in chess, that being "exceptional visual memory, combination power, speed of calculation, power of concentration and logical thinking" (Djakow et al. cited in Ferguson, 1995: 2), the more relevant part for this study was the skills developed through playing chess. Ferguson argued that '[c]hess has been proven to enhance creativity, concentration, critical thinking skills, memory, academic achievement, problem solving,…."(1995: 15).

According to Ferguson who was the program director and conducted a four year study (1979-1983) as part of an experiment in gifted children's education program (no initial hypothesis related to any of the activities existed), significant increases in critical thinking and creativity were reported for the chess group learners' as well as superior gains over the other activities groups. "The primary goal of the study was to provide challenging experiences that would stimulate the development of critical and creative thinking" (Ferguson, 1995: 4). The participants were Grade 7-9 mentally gifted learners (IQ of 130 or above) with individual education plans and interest based prescribed activities. Thus no randomized sampling could take place. Learners joined their interest groups and met once a week and engaged in their preferred activity. Their achievements were monitored by administrating pre and post thinking tests at the end of each school year. However, as the test group included only 15 learners, replication of this study with a larger test group was recommended.

In a later study conducted by Ferguson at an 'ordinary' rural school (mean IQ-104.6), between September 1987 and May 1988, all Grade 6 learners were required to participate in chess lessons – two to three times a week, in addition to playing chess daily. All learners were subjected to pre and post memory and verbal reasoning tests. Gains on the tests were compared to the national norms and showed significant improvement in both memory and verbal reasoning (Ferguson, 1995). Yet again, the test group was only 14 students and the researcher encouraged replication of the study.

As no other research has been published in South Africa on chess in education, Van Zyl's Doctoral dissertation (1991) was of great significance. She conducted a study on eighty chess players who represented their schools in league matches. These players can be considered as being relatively high level players. Her found that:

- chess players performed significantly better in mathematics than the non-players in the higher grades (standard 6, 7 & 8), with no significant differences in standard 3, 4 and 5.

- chess players' mathematic marks dropped much less than the drop of the non-players as they progressed through standards.
- learners that played chess had a significantly higher average total IQ.

Similarly to some of the international studies, Van Zyl focused on high level chess players. The question arises as to whether the same findings are applicable to the 'ordinary', less competitive chess players. One has to exercise caution in generalizing findings based on a study of highly skilled chess players and attempt to apply them to the less committed, 'just for fun' players, without further research. The researcher's conclusion that chess contributed to an improved IQ and performances in mathematics, laid the foundation for further research about the potential contribution of playing chess to South African learners. Horgan (1987), while aiming to prove the educational benefits of playing chess, proved that good chess players are also capable mathematicians. She designed an experiment that intended to check the ability of young chess players to deal with a mathematically complex question. Her study focused on high level chess players and their ability to answer correctly what was considered a complicated probability question without prior knowledge in probability theory. She reported that intuitively, all players answered the question correctly, choosing out of two possible tournaments the one in which they were more likely to win all their games, taking into consideration the number of rounds and their rating compared to their opponents' ratings. However, her conclusion, that; "...[p]robability theory is notoriously counter intuitive. If chess develops correct intuitions about probabilities, there could be tremendous educational advantages" (Horgan, 1987: 8), was based on a single question, and requires further study.

Two experimental studies which took place in the 1970s were of great significance. Frank's Zaire study (cited in Ferguson, 1995: 3) was conducted during the 1973-74 school year and involved 92 students, 16-18 years old. All students took a battery of tests before the school year and were split randomly into two equal size groups of 46 learners each. One of the groups, the experimental group, was given a chess course- two hours per week; with optional after school and during vacation play times. The researcher intended to find out (first hypothesis) whether the ability to learn and play chess well is a function of one or more of the following: spatial aptitude, perceptive speed, reasoning, creativity, general intelligence and visa versa; can learning chess influence any of the above (second hypothesis). Significant correlation was found between the ability to play chess well and spatial, numerical, administrative and paper work abilities. Even more relevant was the partial confirmation of Frank's second hypothesis.

His results confirmed that studying chess influenced positively numerical and verbal aptitudes for the majority of chess players. It is important to note that while the chess training and the playing periods were relatively short, their positive influences were for all players, not just for the good players.

In Belgium, Christiaen (1976) conducted an experimental study on Chess and Cognitive Development. Using Piaget's 'stage' theory, and a set of tests, Christiaen aimed to test whether a stimulated and enriched environment (chess coaching) accelerates the transition of learners from stage three (concrete level) to stage four (formal level). Forty Grade 5 learners were randomly selected and divided into two groups consisting of 20 learners each. Learners of the trial group received weekly one hour chess lessons over 42 weeks. Participation was compulsory. During the same period, the control group teachers were free to do any other activity with the learners. I assume that since no pre-testing took place it was impossible to check whether acceleration (using Piaget stages) within the trial group was faster than acceleration within the control group. However, academic results at the end of both, 5th grade and 6th grade for the trial group compared to the control group were significantly higher.

The Zaire study that was done at the Uni Protestant school and the Belgium study that took place at Municipal school could be classified as true experimental studies. They tested and found that teaching and playing chess had a positive influence on the development of numerical and verbal aptitudes (Frank) and on overall school results (Christiaen). This applied to the 'ordinary' learners, diffusing the common belief that chess was only for the brainy.

2.3 MATHEMATICS

The various definitions of mathematics relate it to be the study of numbers, quantities and shapes. It is broadly agreed that mathematical competence is a necessary life skill.

2.3.1 <u>The South African Context</u>

As noted by the Mathematics Education Community (Adler et al., 2000) in their submission to the Council of Education Ministers, there is a crisis in mathematics education in South Africa. For a stable and growing economy it is essential for a Nation to have:

- numerically literate citizens able to engage with and understand mathematics

- a numerically literate workforce since mathematics is the key in all science and technology related careers in industry and people are employed for their ability to solve problems
- a growing community of mathematicians able to develop the knowledge base of mathematics

The repeatedly poor matriculation results were further aggravated by the fact that "less than 1% of African matriculation candidates achieve A or B for Mathematics Higher Grade" (Adler et al., 2000: 2). Their recommendations to improve the situation were mainly channelled through improvement of existing teachers and under utilised resources and while extremely important, should not be exclusive. Other ways to improve mathematical achievement should be explored.

One of the characteristics of Outcomes Based Education, as specified by The Revised National Curriculum Statement (Department of Education, 2001: 4) "Is an activity-based approach to education designed to promote problem-solving and critical thinking".

Consolidated into five learning outcomes (Department of Education, 2001) in the learning area of mathematics, the learner is expected to be able to:

- recognise, describe and represent numbers (and their relationships) with competence and confidence in solving problems;
- recognise, describe and represent patterns and relationships, and solve problems using algebraic language and skills;
- describe and represent characteristics and relationships between 2-D shapes and 3-D objects in a variety of orientations and positions;
- use appropriate measuring units, instruments and formulate in a variety of contexts;
- and collect, summarise, display and critically analyse data to draw conclusions and make predictions, and to interpret and determine chance variation.

As stated before, the improvement of learners' ability to perform the above mathematical activities is a main objective. While addressing directly the learning area of mathematics, the development of the more 'general' skills, which are required to do mathematics, should not be overlooked.

2.3.2 Skills required in Mathematics

Gill defines 'Mathematical proficiency' as "what we believe is necessary for anyone to learn mathematics successfully" (2001: 2). This proficiency can be achieved by focusing on five components which are closely interconnected and contribute to each other (Gill, 2001):

- conceptual understanding – comprehension of mathematical concepts, operations and relations. The ability to see behind the isolated method or example. The knowledge gets connected and the learner understands the idea and the contexts to which it is applicable.
- procedural fluency – a procedure being a set of linked and ordered activities requires the skill in carrying it out, accurately, efficiently and appropriately.
- strategic competency – ability to formulate, represent and solve mathematical problems.
- adaptive reasoning – capacity for logical thought, reflection, explanation and justification.
- productive disposition – the tendency to see mathematics as sensible, useful and worthwhile.

Teaching and developing these proficiencies in context is an obvious way to teach mathematics. The development of general skills of problem solving should be done in conjunction with the development of specific knowledge (Nisbet, 1990; Perkins & Solomon, 1989). However, skills development in context should not be regarded as the only way. It is proposed that chess may provide a useful 'other' context for promoting skills and habits of mind that are important to learning and doing mathematics. Subsequently the area of transferability is discussed in the next section.

The ability to formulate, represent and solve mathematical problems (strategic competency) as well as the capacity for logical thought, reflection and explanation (adaptive reasoning) can be matched to some of the proficiencies acquired by a player while developing chess skills.

2.4 2.4 TRANSFER OF SKILLS

"Transfer of learning occurs when learning in one context or with one set of materials impacts on performance in another context or with other related materials" (Perkins & Salomon, 1992: 2). Transfer between similar contexts is referred to as 'near transfer' while transfer between contexts, which seem remote to one another, is referred to as 'far transfer' (Perkins & Salomon, 1992; Bransford et al., 1999).

2.4.1 Thinking – can it be taught?

It is common practice of any teacher (or parent) to use the instructive word "THINK!" What it really means is: 'exercise your mind and make a decision'. Can thinking be taught? Can the process be developed? If developed in one context will it be transferable to another?
The concept of teaching thinking and improvement of intellect has been a prime education goal since ancient Greece (Nisbet, 1990; Wilson, 2000). The development of constructivist psychology challenged "the notion of inborn intelligence which dominated educational practice until the 1960s" (Wilson, 2000: 29) and was followed by more recent suggestions to introduce the development of 'key' skills such as problem solving and decision-making into primary and secondary education.

Figure 2-1 is a possible way to represent areas of thinking (Einnis cited in Hanson, 1991: 94).

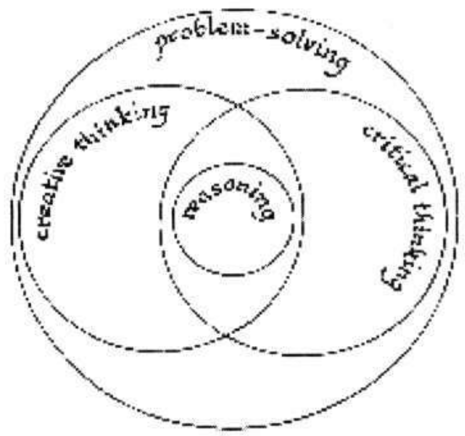


Figure 2-1 Areas of Thinking

Hanson (1991: 94) further defined critical thinking, creative thinking and reasoning as following:

- critical thinking - disciplined thinking, in accordance with given or accepted principles, that is focused on deciding what reasonably to believe or do.
- creative thinking - disciplined thinking that realises new problems, strategies and conclusions in focusing on what reasonably to believe or do.
- reasoning - deductive and inductive capability and the resolution of value judgement.

Altogether, these can be considered *skills of enquiry.*

However, are these skills of enquiry - the thinking skills, best developed in a specific context, or, are there other ways to develop them, through specially designed programmes which are not content specific? The research literature that addressed these main streams, highlighted the differences between them and provided supportive evidence to their aptness.

> Should we teach entirely for richly developed local knowledge, subject matter by subject matter? Or should we invest a significant portion of educational resources in developing general skills of problem solving, self-management and so on?" (Perkins & Solomon, 1996: 17).

Perkins & Solomon (1996) referred to research supporting the development of general intelligence as 'The Golden Age of General Heuristics'. Up to the late 1960s, largely based on works by Polya (cited in Perkins & Solomon, 1996) on analysis of mathematical problem solving and Ernst & Newell (cited in Perkins & Solomon, 1996) and Newell & Simon (cited in Perkins & Solomon, 1996) on Artificial Intelligence, it was widely believed that general strategies were the key and that they were operational on any database of knowledge.

Referring to later research, Perkins & Solomon (1996) presented counter claims against the centrality of general ability in human thinking, based on several selected studies, which proved that:

- a broad 'database' of knowledge results in the expert being able to perform better than the less experienced in the same context
- generic programs in AI were not suitable for complex domains
- and logic imbedded in one context did not improve results in another - lack of transfer.

While presenting both sides of the debate, their logical and constructive suggestion was not to view it as either/or but to further learn how general and local knowledge interact in human cognition for further improvement in education methods. Similarly, Nisbet (1990) presented the view that schools should teach learning strategies – general skills, as well as develop specific skills. Yet the main objective was for the learners to internalise these strategies - "learning to learn means taking over from the teacher the control and management of your own learning and thinking" (Nisbet, 1990: 2)

It has been widely agreed among researchers, that it is possible to teach and develop thinking skills yet no conclusive resolution has been reached about the best way to implement it.

2.4.2 Will transfer occur?

"[t]he critical test in evaluating the teaching of thinking is transfer" (Nisbet, 1990: 3). Seemingly, the way to evaluate whether playing chess teaches thinking was by looking for transfer to another context e.g. mathematics. Singley & Anderson (cited in Anderson et al., 1996: 7) showed that "transfer between tasks is a function of the degree to which the tasks share cognitive elements". Perkins & Solomon (cited in Nisbet, 1990) distinguish between the 'low road' and the 'high road' transfers. While the 'low road' transfer was 'the automatic triggering of well rehearsed schemata' and was applicable to most of the learning in the early stages of education, the 'high road' transfer was for the more advanced stages. It involves "active decontextualisation… the deliberate mindful abstraction of a principle and its application to a different context" (Perkins & Solomon cited in Nisbet, 1990: 3).

While learning and playing the game, a chess player will develop, among other proficiencies, chess related strategic competency and reasoning. He will develop the ability to think in a structured and logical way to plan and to solve chess problems as well as the ability to explain the reasoning behind his actions.

Van Zyl (1991) identified several skills required from a chess player directly linked to cognitive development, among them; concentration, concept forming, ability to see from another perspective, ranking and creativity. Langen (cited in Ferguson, 1995: 13) claimed that "children who learn chess at an early age achieve more in the traditional maths and sciences…….The most striking benefits are those associated with problem-solving and creativity".

The process of learning to play chess starts with understanding the goals of the game, the various pieces, their initial positions their correct movements and the power of each piece. All assist to develop the conceptual understanding of the game. The rules of the game which include the correct movements of the pieces within time constrains develop procedural fluency. As the player progresses, so do his skills to plan his game. He is able to evaluate his position compared to that of his opponent. Before each move, an evaluation of the position is done, sometimes a problem has to be solved and always a decision has to be taken – all relate to strategic competency. A player needs to respond to his opponent's move, which more often than other is not the anticipated one. He has to keep reflecting and adapting to a changing logical situation – adaptive reasoning.

While all the above require a certain level of knowledge which is context related (chess), is it likely for these competencies to develop not just in context but also in general? A clear mapping exists between chess skills and the components of mathematical proficiencies as listed by Gill (2001). The overlapping of cognitive skills required by both chess and mathematics suggests that developing those skills in chess is likely to result in a transfer to mathematics. Since the contents are different, it is the application of concepts learnt in one context and applied to another, thus 'high' and 'far' transfer as per Figure 2-2 will occur.

TRANSFER	low (simple thinking)	high (advanced thinking)
near (similar context)		
far (remote context)		chess to mathematics

Figure 2-2 Transfer from chess to mathematics

2.5 CONCLUSION

The number of published studies in the area of chess and mathematics is limited. Several of the selected studies; Christiaen (1976), Frank cited in Ferguson (1995), Ferguson (1995) and Van Zyl (1991), showed through experiment the positive impact of chess on learners' critical thinking and mathematics achievement. The ongoing debate between those who believe that general thinking skills can be taught 'content-free' and those who advocate the infusion of thinking as context-specific throughout the established curriculum, is far from over (Anderson et al., 1996; Nisbet, 1990; Perkins & Solomon, 1989). However, recent approaches suggest that the two somehow opposing 'schools' should not be regarded as mutually exclusive and that there is room for a synthesis - "General and specialized knowledge function in close partnership" (Anderson et al., 1996: 16).

This study intends to further contribute to growing evidence that chess has educational worth to the learners for the study of mathematics since they share similar cognitive elements.

CHAPTER 3

RESEARCH METHODOLOGY

This study was done as a quasi-experimental, ex post facto research using data collection methods, which included; interviews, questionnaires and extracts from school records. I will explain in this chapter the suitability of this design to answer the main research questions:

- does playing chess have a positive impact on a learner's mathematics achievement?
- does the length of exposure to chess impact on mathematics achievement?

3.1 DESIGN OF STUDY

As my main research question was the possible relationship between playing chess and mathematic achievement, a quantitative study comparing mathematical achievement of learners who were chess players to non-chess playing learners was the most appropriate way. Quantitative research is usually referred to as one "that is aimed at testing theories, determining facts, statistical analysis, demonstrating relationships between variables and prediction..." (Van der Merwe, 1996: 282). Presenting and supporting the outcomes of a research question based on measured data, using objective statistical analysis was my preferred choice.

In an attempt to avoid conducting a lengthy and expensive experiment, which was beyond my resources, I chose to conduct an *ex post facto* study, using existing data. "In the context of social and educational research the phrase means 'after the fact' or 'retrospectively' and refers to those studies which investigate possible cause-and-effect relationships by observing an existing condition or state of affairs and searching back in time..."(Cohen et al., 2000: 205). This type of study simulates an experiment 'backwards'. It compares measurements taken at present to recorded measurements taken for the same group prior to a treatment (event) taking place, assuming that this affected the recent measurements.

Black defines ex post facto studies as those that "tend to look for differences in group characteristics, traits or preferences based upon life experiences" (2002: 45).

The experiment was designed to measure the possible effect of playing chess on mathematic achievement of Senior Primary Learners within a school, using actual 'pre' and 'post' mathematics achievement marks as indicator for mathematics achievements.

A Senior Primary School will normally have learners from Grade 4 to Grade 7. However, in some of the local schools, Senior Primary is from Grade 5 to Grade 7. While the first year in the Senior Primary School varies between schools, the final year at the Senior Primary is always Grade 7, with High School starting at Grade 8.

Senior Primary learners, from each of two schools, who were active chess players in June 2003 were identified and selected to participate in the study (details on process of identification, criteria for selection and limitation are discussed in sections 3.2, 3.3 & 3.5). This group of learners was called "Test group A" and included all chess players. For each selected chess player (who was in group A), his mathematics mark as appeared in his school records on the first year at the Senior Primary School, was obtained. This mathematics mark was a variable measured prior to exposure to chess. For each chess player learner, a (matched) non-player learner from the same grade and with the same entry year mathematics mark had to be found. This group was called the "Control group B" as they were not exposed to the treatment, which was: to learn and play chess. For all learners selected (chess-players and non-players), their June 2003 mathematics marks were obtained from school records.

Using Creswell's definitions and diagrams (1994: 131-133), the above experiment can be illustrated as following:

		Key
Group A	O -------- X -------- O	X - the exposure of a group to an experimental event whose effects are to be measured. In this study, X was learning and playing chess.
Group B	O -------------------- O	O - a measurement. In this study, O are mathematics marks
		X and O on the same row apply to the same person. Xs and Os vertical to one another are simultaneous

Figure 3-1 Pre-test and Post-test Control Group Design

Since it was not possible to set up a true experimental educational research with randomly selected schools and learners (Cohen et al., 2000: 214), a quasi-experimental research has been used. A random selection of schools would have been impossible since this study focuses on mathematical achievement of learners who are chess players and the selected schools had to be schools that have on-going chess activities / clubs and therefore have learners who are chess players. As will be explained in detail in section 3.2, during the matching process and the search for a non-player learner for each of the chess players, it became clear for one of the schools, that a 100% match was not achievable and should I wish to stick rigidly to the original experiment design, a major portion of data relating to chess players would become unusable.

To avoid the above and maximise utilisation of collected information, the initial experiment design was expanded to incorporate two experiments, as presented in Figures 3-2 & 3-3.

Experiment # 1:
For all chess players, a pre-test and post-test Control Group Design was used.

Group A O1 -------- X -------- O2

Group ALL O1 ----------- -------- O2

Figure 3-2 Chess players and all learners; pre-test and post-test Control Group Design

Key to Figure 3-2:

Group A	- all chess players
Group ALL	- all learners in the grade
O1	- June mathematics mark at the first year in Senior Primary
O2	- June 2003 mathematics mark
X	- the experimental event - learning and playing chess.

Experiment # 2:

This was done as per the original plan but with smaller groups. Creswell (1994: 132) defined this design as a nonequivalent (pre-test and post-test) Control Group Design and as being a "popular approach to quasi-experiments, the experimental Group A and the control Group B are selected without random assignment. Both groups take a pre-test and post-test, and only the experimental group received the treatment".

Group MP	O1 -------- X -------- O2
Group MN	O1 -------------------- O2

Figure 3-3 Matched Pairs; pre-test and post-test Control Group Design

Key to Figure 3-3:

Group MP	- the matched chess players
Group MN	- the matched non-players
O1	- June mathematics mark at the first year in Senior Primary
O2	- June 2003 mathematics mark
X	- the experimental event - learning and playing chess.

3.2 SAMPLE

As stated earlier, the sampling could not be done randomly as the schools selected had to have a substantial number of chess players.

3.2.1 Description of schools

Guided by information from KZN Junior Chess Association, I approached schools that were known to have active chess clubs. My initial criteria for school selection were:

- schools that had at least 20 active chess players
- schools that were not too far from each other (the study was self funded and several trips to each school were anticipated)

- and schools that represented different socio-economic populations.

Of the schools that met the criteria, two Senior Primary Schools within the eThekwini Municipality agreed to participate in the study. A third school which was approached via its chess coach, declined to participate.

The first school, which was called for the purpose of this study – East Senior Primary School, was a multi racial, well resourced government school, in an upper middle class area. Parents' contribution to school tuition was over R2000 per year. During 2003, it had approximately 750 learners (Grade 4 to Grade 7) and an average of 30 learners per classroom. Jane was the teacher who overlooked the weekly chess 'club' activity that took place in the school library. An external coach was employed to assist in teaching the game and helped the learners to improve. More than ninety learners from all grades were active players at the school's chess club.

The second school was an all-African school, situated at a low socio-economic area in Umlazi Township. Parents' contribution for school fees was less than R100 per year. For the purpose of this study the school was referred to as South Senior Primary School. The school had over 800 learners (Grade 5 to Grade 7) and an average of 80 learners per classroom. John has been running a daily chess club at school and has been the teacher in-charge, as well as the chess coach. The activities took place in one of the classrooms. More than thirty learners have been participating almost daily in the school's after-hours chess activities.

For both schools, the process and criteria for selection of learners to participate in the study were the same; the teacher in-charge provided lists of all learners who played chess at the school's clubs. It was my intention to include every learner who was an active chess player, in the test group. However, learners from the entry grade to each school had to be excluded. This was due to the following reasons:

- a reliable 'pre fact' mathematics mark was required and the learners' final Junior Primary mark was in most instances not available as a percentage but as assessment rubrics
- most learners' started to play in the second quarter of their first year at Senior Primary, thus having had less than three months of exposure to chess in their first year at Senior Primary.

The exclusion applied to all Grade 4 players at East Senior Primary School (the school has Grade 4 up to Grade 7 learners) and to all Grade 5 players at South Senior Primary School (the school has Grade 5 up to Grade 7 learners). This reduced the number of players in the South Primary School to below 20. However I decided to continue the process and collect further data from both schools. For each of the chess players selected into the test group, a matched learner who was not a chess player had to be found.

3.2.2 Find matching non-players

The following rules were used as the Matching Criteria during the selection of non-players as matched to the chess players:

1. The non-player learner must be presently at the same grade as the chess player.
2. The preferred choice was to have the same mathematics mark at entry year in the Senior Primary School and the same gender for both the player and the matched non-player.
   * If not found,
     allowed for a non-player with a mathematics mark which was up to two percent higher and of the same gender as the chess player.
     * If not found,
       allowed for a non-player of a different gender but with the same mathematics mark as the chess player.
       * If not found,
         allowed for a non-player of different gender and with a mathematics mark which was up to two percent higher than the chess player learner.

Based on the lists of chess players received from Jane and John, and applying the matching criteria (it was assumed that learners that were not on the teachers' lists of chess players did not play chess), an initial sample for test and control groups was created. I was supposed to build a control group with the same sample size as the test group. Table 3-1 provides a summary of learners selected in this initial stage.

Table 3-1 East and South Senior Primary Schools: Initial test and control groups

School	Grade	Players			Assumed Non-Players		
		Male	Female	Total	Male	Female	Total
East Senior Primary	5	27	3	30	18	12	30
	6	18	2	20	17	3	20
	7	11	1	12	10	2	12
	Total	56	6	62	45	17	62
South Senior Primary	6	3	5	8	6	1	7
	7	8	0	8	6	2	8
	Total	11	5	16	12	3	15

During the process of data collection, a third group emerged – learners who used to play chess but stopped playing. While the existence of past player learners was expected (Hermelin, 2002) it was surprisingly large at the East Senior Primary School and affected the process of data collection.

Table 3-2 East and South Senior Primary Schools: Learners participating in the study

School	Grade	Players			Non-Players			Used to Play		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
East Senior Primary	5	33	9	42	10	5	15	4	4	8
	6	20	2	22	10	4	14	3	0	3
	7	11	1	12	7	2	9	6	0	6
	Total	64	12	76	27	11	38	13	4	17
South Senior Primary	6	2	5	7	6	1	7	0	0	0
	7	7	0	7	6	1	7	0	~~1~~	~~1~~
	Total	9	5	14	12	2	14	0	~~1~~	~~1~~

As presented in table 3-2, resulting from the information obtained from the questionnaire (section 3.3.3), the original categorisation of the participants changed (non-players moved to players and to used to play categories) and a few non players were added for the purpose of obtaining a larger number of matched pairs. The only learner that used to play at the South Senior Primary School was excluded from the study since no analysis could take place.

3.1 3.3 DATA COLLECTION

The data collection was done in stages over a period of two months using the following procedure:

- obtain names of all known chess Players from the teachers in charge (interview)
- obtain mathematics marks for all the above learners (school records)
- find matching non-players learners and obtain their mathematics marks (school records)
- and have all learners identified in steps (a) and (c) complete a questionnaire.

The above stages will be described in detail, including challenges addressed and obstacles that had to be overcome in both schools.

The principals of both schools gave their permission to access school and learner's records. However, it had to be done in the presence of a teacher. This resulted in limited time slots for the collection process, which had to be worked around the teachers' busy teaching schedules. It was also my intention to limit as much as possible any inconvenience to the schools as a whole and by doing so, I ended up repeating certain processes.

3.3.1 Teachers' interview

The first step towards setting up the test group was a list of all chess players. The teachers in charge of the chess activity at their schools provided the lists. At this stage the teachers provided information about:

- availability of data; learners mathematics marks and grade averages
- possible routes to obtain data required (learners' files, teachers' records)
- and teachers' involvement in supervising the completion of the questionnaire by the learners

The teachers' input was essential to ensure accessibility to the required data.

3.3.2 Accessing School Records

The next step was accessing school records and retrieving the learner's first mid-year mathematics mark. East Senior Primary School keeps a central filing system with a file for each learner. In addition, a database with all marks is available. For each learner who was identified by the teacher as a chess player, his / her Grade 4 mid-year mathematics mark was retrieved from his / her school file. For each player selected, a non-player with the same Grade 4 mark had to be found. It was done by going through the individual learners' files as well as the school's printouts in an attempt to find the best match.

South Senior Primary School does not have a central filing for the individual learners. However, all educators' progress books are kept and these were used to extract the Grade 5 mid-year mathematics marks for the chess players, to find the matching non-players and the present mid-year marks. The number of chess players at South Senior Primary School was small in comparison to the East Senior Primary and the teacher in charge knew all players well.

3.3.3 The Questionnaire

The questionnaire was filled-in by all the learners that were selected to participate in the study. Since some information could not be provided by the teachers nor was it available from school records, the learners had to provide the following information:

- is the learner still playing chess
- how frequently
- for how long did he play
- where did he play
- who did he play with
- and his attitudes and perceptions about the game

The questions related to the last three topics were not required for the research questions and were included to gain broader understanding about learners' views. As detailed in section 3.3 (data collection), information obtained via the questionnaire impacted on the sample sizes and on the decision to change /expand the original design. The main aims of the questionnaire were:

- to ensure that the matched non-players were really non-players
- to find out for how long and how frequently the chess playing learners played
- and to obtain qualitative information about attitudes and perceptions towards the game and its possible merits (as viewed by the learners)

The teachers in charge of chess administrated the process. I provided both teachers with the names of the learners (players and non-players) that were to complete the questionnaire.

At the South Senior Primary School, all chess players filled the questionnaire during their daily after-school chess activity. The non-players were called out from their classes. No language /

understanding problems were reported and it was a single phase process as only one learner who was originally identified as non-player turned out to be an ex-player. One Grade 6 player had to be excluded since his Grade 5 mark in mathematics was not available.

The same initial process has been followed at the East Senior Primary School. However the information obtain via the questionnaire revealed that:

- fourteen additional learners were active chess players yet did not participate in school formal activities, thus were not identified as chess players by the teacher in charge
- and a surprisingly high number of chess players who used to play regularly and stopped (seventeen learners).

The 'newly found' chess players as well as 'used to play chess' learners were originally assumed to be non-players had to be moved from their matched non-players' groups to their correct groups. The matching process had to be re-done in an attempt to find a non-players learners who could be matched to the 'newly found' chess players as well as for the originally identified players who lost their 'match'. The search for additional matching non-players was only partially successful.

In conclusion all required data was obtained.

3.4 ANALYSIS OF DATA

The following section will present and explain the process of transforming the data collected into combined data files, which included the learners' mathematics marks and their chess related information obtained from the questionnaire. It will further detail the various descriptive statistics used and the use of *t-test* to determine the level of significance of the changes that occurred to the average mathematics marks of the analysed groups.

3.4.1 Transformation of data

Forms and templates were designed aiming to ensure that all data required for analysis was gathered for all learners that participated in the study. The information required was collected from three sources; the teacher, school records and the learner, and was either used in its raw form or was coded, as per the following key:

Key to Table 3-3:

x - data transferred from source document for analysis in the same form as it has been recorded on the source document

(x) - data appeared on more than one source and was used to validate information.

Coded - data from source document has been transcribed for analysis.

Table 3-3 Sources of data

Data \ Source of Data	Teacher (interview)	School Records	Questionnaire (by Learner)	Researcher	For Research Question
Learner number				x	
Name & Surname	x	(x)	(x)		
School	Coded		(x)	Coded	1 , 2
Grade	x	(x)	(x)		1
Gender			x		1 , 2
Status(Player/Non-Player/ Ex-Player)			x	Coded	1 , 2
Matched Learner number				x	
Exposure				x	2
Period Played			x	Coded	2
Frequency Played			x	Coded	2
Learner's Maths Mark at entry year		x			1 , 2
Learner's Maths Mark at Present Grade		x			1 , 2
Grade Average Maths Mark at entry year (for East SP only)		x			1 , 2
Grade Average Maths Mark at Present (for East SP only)		x			1 , 2

A template spreadsheet was designed to ensure that all the information required for the analysis of both research questions was used. Appendix A illustrates the coding categories and the format in which all data was analysed.

To facilitate the analysis process, the data was grouped into four subsets, each transferred to its own spreadsheet, each having the same format as Appendix A:

- chess players at East Senior Primary School
- chess players and their matched non-players at East Senior Primary School
- chess players and their matched non-players at South Senior Primary School
- and learners that used to play at East Senior Primary School

The questionnaire (Appendix B) was completed by all learners that participated in the study. All learners answered section A of the questionnaire. Section B was answered by learners that used to play chess but stopped. Active chess players answered section C.

Learners' answers to questions A1, B1, B2, B3, C1, C2 & C3 were coded and transferred (as per Table 3-3) to their respective spreadsheet for analysis. The information obtained from these questions was essential for this study.

Learners' answers to questions B4, B5, B6, C4, C5 & C6 (not required for the analysis of the two main research questions) were transferred to three summary forms:

- summary form for active chess players
- summary form for non-players
- summary form for learners that used to play chess

and were used for the quantitative and qualitative analysis related to learners' perceptions about chess.

3.4.2 Descriptive Statistics

The study was conducted at two schools and data was collected for individual learners. The analysis was linked to the research questions by checking the changes to the average mathematics marks for the various subgroups. Did it change for chess players?

Analysis was done for each school comparing:

- mathematical achievements at present grade to the mathematical achievement of the same learners at entry year;
- mathematical achievements of players to the mathematical achievements of their matched non-players.
- and learners' playing habits and their perceptions about the game.

Since grade average mathematics marks were not available for South Senior Primary School, only limited analysis was done with data collected at this school.

3.4.3 Statistical Significance Tests

The *t-test* was applied to determine the level of statistical significance of changes to mathematics marks. As per Bohrnstedt & Knoke (1982) the *t-test* is "a test of significance for continuous variables where the population variance is unknown and the sample is assumed to have been drawn from normally distributed population" (p.154). It has been assumed that the mathematics marks within each grade were normally distributed. Since no randomisation was applied, neither in the selection of the schools nor in the selection of learners in the school, the *t-test* has to be used with caution. However, Bohrnstedt & Knoke (1982) believed that the assumption for sampling was too restrictive and suggested that the test can be used. "..unless we are certain that the underlying population from which the sample is drawn is grossly nonnormal , we can use *t-test* to test a hypothesis even when N is small"(Bohrnstedt & Knoke, 1982: 154). While samples were small it was assumed that the population from which they were drawn was not 'grossly nonnormal' thus the *t test* could be applied.

3.5 LIMITATIONS OF STUDY

Setting up a proper experimental study requires intensive involvement of schools' management, teachers and learners and especially funding. Ideally it would need to be conducted over a long period of time. Whilst it would have been a preferred choice, it was not a practical one within the scope of this study. As can be seen from the literature review, several experimental chess studies did take place and had their share of challenges. They required funding and ran over periods ranging from seven months to three years with intensive involvement of learners and staff (Christiaen, 1976; Ferguson, 1995). By using post event existing information, all data required for the study was obtained with minimal interruption to the learners and staff at the schools involved. While it is possible that some additional information would have been obtained during a real experiment, with pre-event and post-event testing, this study had the advantage that the selected participants' behavior was not affected as it can happen to members of a test group that are aware of them being under observation (Christiaen, 1976: 22).

The use of a questionnaire, which was completed by the learners themselves, was of some concern mainly regarding the accuracy of players' exposure to chess as it was based on the players' memory. The learners had to recall for how long they have been playing and how frequently and then accurately record the information on the questionnaire. Most learners completed all essential data and just few learners had to be approached to clarify their answers since some contradictions occurred. Some learners did not respond to the perceptions questions and due to time constrains were not approached to complete the missing parts, resulting in less data for the perceptions analysis.

3.6 CONCLUSION

The various parts of information, collected from teachers, school records and learners, provided the data required answering the two research questions. Additional quantitative information was obtained and provided some insight to learners' attitudes and perceptions towards the game. The sequence of the data collected, aimed to get reliable and complete information that supported the 'experiment' design, while considering minimal distraction to the schools that participated in this study.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

The reporting and analysis of the results has been done separately for the two schools that participated in the study. The matched pairs groups from both schools were originally the main focus of this study; however, as the data collected at the East Senior Primary School included chess players who were not matched and learners that used to play but stopped, I decided to extend the analysis to cover these groups. Further limited analysis was done by gender.

4.2 RESULTS FOR RESEARCH QUESTION # 1

The results to the first research question - does playing chess improve the players' mathematics achievement – were analysed and reported separately for each of the schools that participated in the study, followed by interpretation and discussion of the results.
The initial identification of chess players was done based on them being pointed out by the teachers in charge. However, the learners' responses to the questionnaire – appendix B determined his/her participation in the study and assisted in establishing the general profiles for *chess player, non-player* and *past player* being:

- *chess player* - a learner that was an active chess player while the study was conducted and had been playing for at least three months.
- *non-player* - a learner that either did not know how to play chess or had previously played for a short period (less than six months).
- *past-player* - a learner that stopped playing yet played for a period of more than six months previously.

4.2.1 <u>East Senior Primary School</u>

The Chess club at East Senior Primary School had more than ninety active chess players. The exclusion of Grade 4 learners and the inclusion of learners that were active chess players but did not play at the school's club resulted in a total of seventy-six players that participated in the study.

4.2.1.1 All Chess Players

The first set of analysis was done on known chess players at the East Senior Primary School at Grades 5, 6 and 7. Matched non-players were found only for part of this group and a separate matched pairs analysis is reported in section 4.2.1.2. Table 4-1 presents a comparison between the mathematics achievements of the group of All Learners in a grade (control group) and the group of Chess Players in the same grade (test group).

Table 4-1 East Senior Primary School: All chess players

Grade	Number of Learners	Group	Average Maths Mark at Grade 4 in %	Average Maths Mark at Present in %	Difference Between Present and Grade 4 Mark	% Difference Between Present and Grade 4 Mark
5	42	Chess Players	78.1	79.7	1.6	2.0
	185	All Learners	72.0	75.0	3.0	4.2
6	22	Chess Players	76.0	74.9	-1.1	-1.4
	194	All Learners	72.0	71.0	-1.0	-1.4
7	12	Chess Players	75.1	84.3	9.2	12.3
	187	All Learners	73.0	72.0	-1.0	-1.4

There were marginal differences between the average mathematics marks for Grade 5 and Grade 6 learners' groups compared to their Grade 4 average mathematics mark. This was true for the All Learners group (+4.2% for Grade 5 and -1.4% for Grade 6) and for the Chess Players group (+2.0% at Grade 5 and -0.4% at Grade 6). A slight improvement for Grade 5 learners and marginal decrease for Grade 6 learners (Chess Players as well as All Learners in the grade) has been noted. However the most noted changes were for Grade 7 Chess Players. While the average mathematics mark of Grade 7 Chess Players compared to that of All Learners in Grade 7 was 2.1% higher at Grade 4, it raised to 12.3% higher at Grade 7. When analysing results for the Grade 7 Chess Players Group, their average Grade 4 mathematics mark improved by 12.3% while the All Learners Group Grade 4 average mathematics mark decreased by 1.4%.

4.2.1.2 Matched Pairs

Table 4-2 presents a comparison between the mathematics achievements of matched pairs - Chess Players and their Matched Non-Players learners. Learners' length of exposure was not taken into consideration in this part of the analysis.

Table 4-2 East Senior Primary School: Matched pairs

Grade	Number of Learners	Group	Average Maths Mark at Grade 4 in %	Average Maths Mark at Present in %	Difference Between Present and Grade 4 Mark	% Difference Between Present and Grade 4 Mark
5	15	Chess Players	72.1	75.1	3.0	4.2
	15	Matched Non-Players	73.3	74.1	0.8	1.1
6	14	Chess Players	71.7	73.5	1.8	2.5
	14	Matched Non-Players	71.9	67.1	-4.8	-6.7
7	9	Chess Players	75.1	83.6	8.5	11.3
	9	Matched Non-Players	75.3	65.0	-9.7	-12.9

Since the basis for matching a Non-Player to a Chess Player was mathematical achievement at Grade 4, the average marks for these groups, were similar by design. It can be noted that they were also close to the whole grade average (see table 4-1). As can be seen from the above table:

- in all three grades (5, 6 & 7), the Chess Players improved their average mathematics marks from their original Grade 4 average mathematics mark.
- In contrast, the average mathematics marks for the Non-Players decreased with the gap between the average mathematics marks of Chess Players and Non-Players increasing from 1% at Grade 5 to 6.4% at Grade 6 and to 18.6% at Grade 7.

The results of the significance testing are presented in section 4.2.1.4, table 4-9.

Figure 4-1 presents the mathematics marks of the nine Chess Players at Grade 7 and their Matched Non-Players. Seven out of the nine Chess Players improved their marks compared to their Grade 4 mathematics marks, while *all* the Grade 7 Non-Players achieved lower marks than their marks at Grade 4.

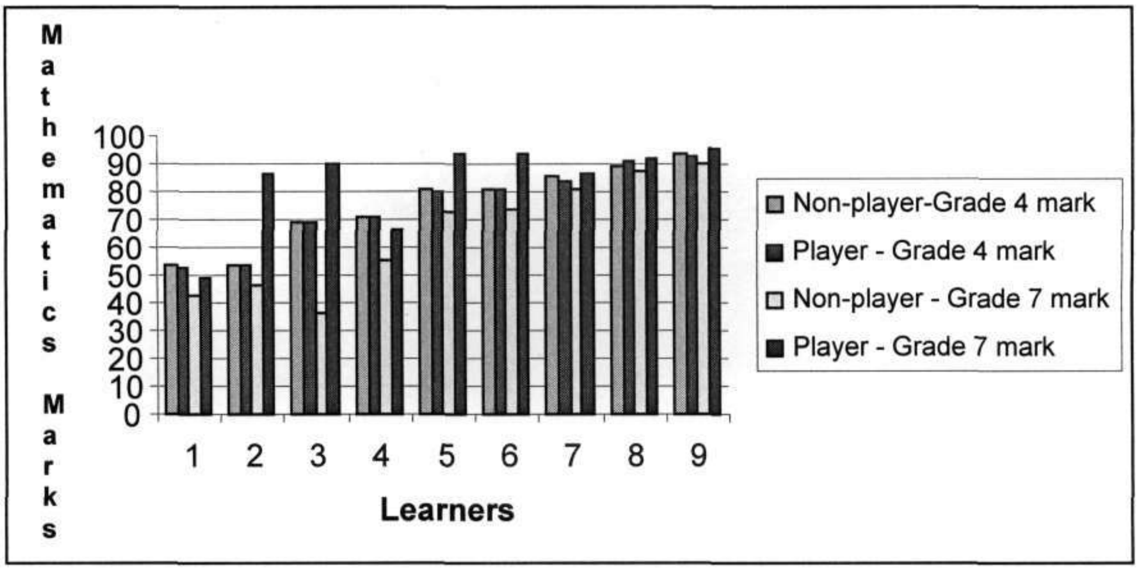


Figure 4-1 East Senior Primary - Matched Pairs - Grade 7 Learners

4.2.1.3 Further Analysis

While numerous analyses were done on the collected data only a few proved to be meaningful and worth reporting. The most interesting finding, related to chess players whose mathematical achievement at Grade 4 was below the grade average. These learners' mathematical achievements improved significantly compared to their matched non-players. In addition, analysis will be reported in this section related to gender and past players.

Below average achievers - These were chess players that achieved below average mathematics marks at Grade 4. In the following section they will be referred to as the 'weaker learners'. As can be seen from Table 4-3, the present average mathematics mark of the weaker learners group was still below the average compared to the All Chess Players Groups at Grades 5, 6 and 7. However, the improvement of the mathematics achievement for the weaker learners compared to their Grade 4 was significantly high (see section 4.2.1.4).

Table 4-3 East Senior Primary School: Comparison between All Chess Players and Chess Players that were the weaker learners at Grade 4

Grade	Number of Learners	Group	Average Maths Mark at Grade 4 in %	Average Maths Mark at Present in%	Difference Between Present and Grade 4 Mark	% Difference Between Present and Grade 4 Mark
5	11	weaker learners - Chess Players	60.6	69.8	9.2	15.2
	42	All Chess Players	78.1	79.7	1.6	2.0
6	7	weaker learners - Chess Players	59.4	68.7	9.3	15.7
	22	All Chess Players	76.0	74.9	-1.1	-1.4
7	5	weaker learners - Chess Players	59.6	73	13.4	22.5
	11	All Chess Players	75.1	84.3	9.2	12.3

The above was further emphasised when comparing the weak learners who played chess to their matched Non-Players (Table 4-4 & Figure 4-2). While the weak learners who played chess improved by 11.7% at Grade 5 (compared to Grade 4), by 15.6% at Grade 6 and 17.8% at Grade 7, their matched Non-Players showed a decline at Grade 6 with a larger decline at Grade 7. The gap between the average mathematics marks of the weaker learners (at Grade 4) Chess Players and their matched Non-Players increased from 0% at Grade 5 to 12.1% at Grade 6 and further to 27.8% at Grade 7.

Table 4-4 East Senior Primary School: Comparison between Chess Players and their Matched Non-Players; the weak learners

Grade	Number of Learners	Group	Average Maths Mark at Grade 4 in %	Average Maths Mark at Present in %	Difference Between Present and Grade 4 Mark	% Difference Between Present and Grade 4 Mark
5	7	Chess Players	61.3	68.4	7.1	11.6
	7	Non-Players	63.4	68.4	5.0	7.9
6	7	Chess Players	59.4	68.7	9.3	15.7
	7	Non-Players	59.7	56.6	-3.1	-5.2
7	4	Chess Players	61.8	72.8	11.0	17.8
	4	Non-Players	62.0	45.0	-17.0	-27.4

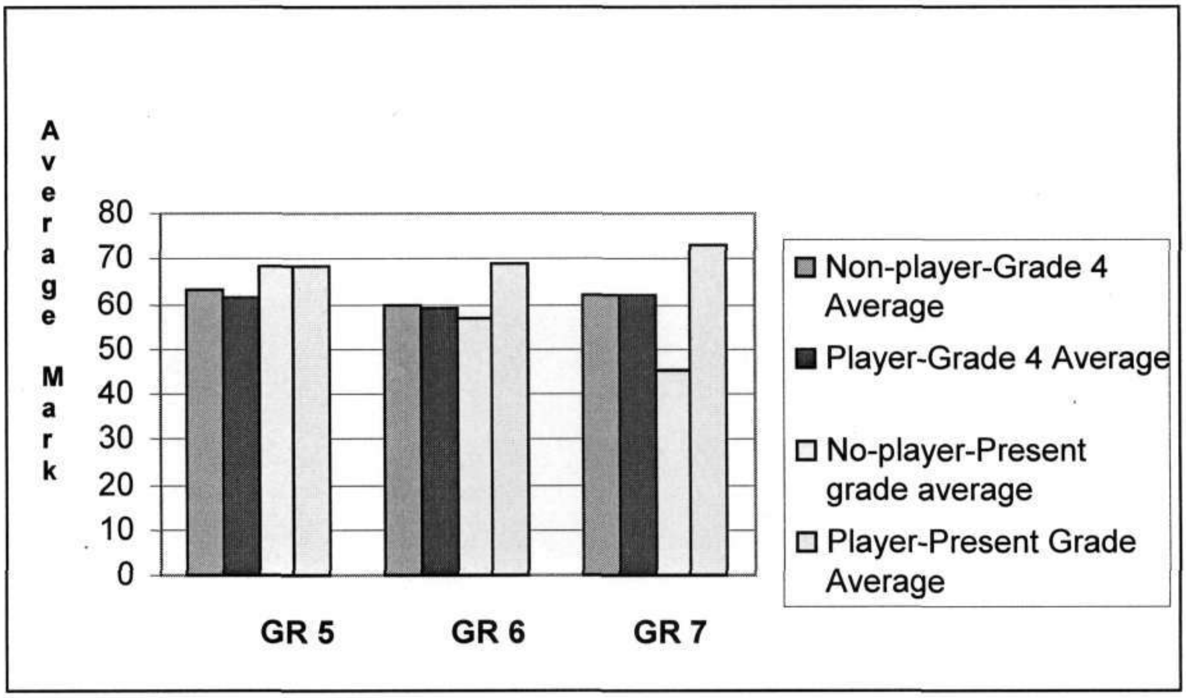


Figure 4-2 East Senior Primary School; Matched pairs – the weaker learners

The findings relating to the positive affect of playing chess on the mathematical achievement of the weaker learners at all grades are of great significance as no reference was found in the literature to a study or results pointing specifically in this direction. Van Zyl (1991) who focused on high level chess players found significant differences between players and non-players only from Grade 8 and above. Ferguson's main study was with gifted children (1995) and Frank (cited in Ferguson, 1995) did not report on differences between levels of improvement for various groups.

Analysis by Gender - the ratio of female to male at East Senior Primary School was close to 1:1, however, the number of female chess players was much lower when compared to the male chess players, in total and within each grade. The number of chess players decreased by grade. However, while 21.4% of the chess players at Grade 5 were female only 9.1% females (two) played at Grade 6 and only 8.7% of the chess players (one) at Grade 7. According to Narayan (2004), only about 7.5% of the chess players in US were women. The only countries that had number of women chess players comparable to men chess players were Hungary, Ukraine and China.

Table 4-5 East Senior Primary School: Chess players by gender

Grade		Chess Players	All	% of Players
5	Male	33	91	78.6
	Female	9	94	21.4
	Total	42	185	100
6	Male	20	93	90.9
	Female	2	101	9.1
	Total	22	194	100
7	Male	11	100	91.7
	Female	1	87	8.3
	Total	12	187	100

With such low number of female Chess Players, a comparative analysis between mathematical achievements of Male Chess Players and Female Chess Players could not be done. However, as presented in Table 4-6, all Female Chess Players at East Senior Primary who were weak learners at Grade 4 achieved vast improvement in their mathematics marks at their present grade.

Table 4-6 East Senior Primary School: Female Chess Players who were below average mathematics achievers at Grade 4

Grade	Number of Learners	**Maths Mark at Grade 4 in %**	**Maths Mark at Present in %**	**Difference Between Present and Grade 4 Mark**	**% Difference Between Present and Grade 4 Mark**
5	1	38	65	27	71.1
6	2	47	61	14	29.8
		67	76	9	13.4
7	1	54	86	32	59.3

Analysis of Past Players - I was interested to find out whether the mathematics achievement of learners that used to play chess and stopped improved in a similar way to that of active chess players. Table 4-7 was an expansion of Table 4-1 and included data for Past Chess Players.

However, while the average mathematics marks at Grade 4 for Past Chess Players were higher than that of the Chess Players at Grade 4, the average mathematics mark for the Past Chess Players was lower than that of the active Chess Players (76.3 compared to 84.3) at Grade 7. At Grade 7, Chess Players' average mathematics achievement improved by 12.3% compared to their Grade 4 mathematics achievement, yet the average mathematics achievement of Grade 7 Past Players decreased by 7.8% compared to their Grade 4 average mathematics achievement.

Table 4-7 East Senior Primary School: Comparison of changes in mathematical achievement between Past Chess Players, Chess Players and All Learners

Grade	Number of Learners	Group	Average Maths Mark at Grade 4	Average Maths Mark at Present	Difference Between Present and Grade 4 Mark	% Difference Between Present and Grade 4 Mark
5	185	All Learners	72.0	75.0	3.0	4.2
	42	Chess Players	78.1	79.7	1.6	2.0
	8	Past Chess Players	80.1	81.3	1.2	1.5
6	194	All Learners	72.0	71.0	-1.0	-1.4
	22	Chess Players	76.0	74.9	-1.1	-1.4
	3	Past Chess Players	86.0	84.0	-2.0	-2.3
7	187	All Learners	73.0	72.0	-1.0	-1.4
	11	Chess Players	75.1	84.3	9.2	12.3
	6	Past Chess Players	82.8	76.3	-6.5	-7.9

As can be seen from Figure 4-3, the majority of Past Chess Players (five out of six) achieved lower mathematics marks at Grade 7 compared to their marks at Grade 4.

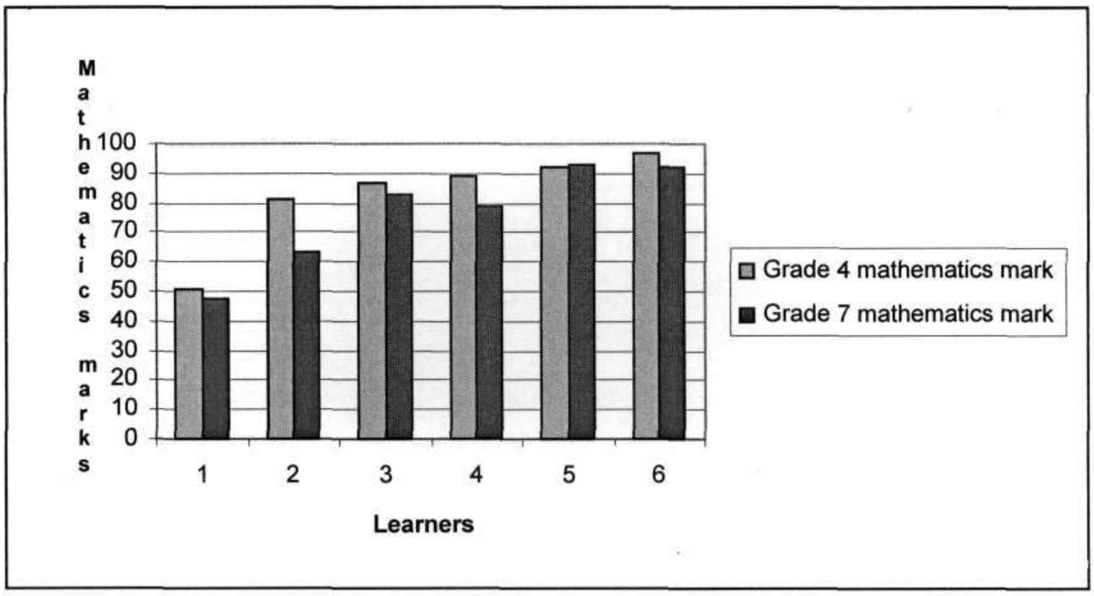


Figure 4-3 East Senior Primary School - Grade 7 Past Players.

4.2.1.4 Significance testing

For several of the previously analysed sub-groups of Chess Players, mathematical achievement improved since they started to play chess. However, were these improvements significant? The following hypothesis were considered:

- H_o: playing chess did not improve mathematical achievement.
- H_1: playing chess improved mathematical achievement.

I followed Underhill & Bradfield (1996: 197) suggested approach for Hypothesis testing and verbal description for Significance level.

Table 4-8 Verbal description based on Reported Probability

Reported Probability	Verbal Description
P>0.20	not significant
P<0.20	possibly significant
P<0.10	nearly significant
P<0.05	significant
P<0.01	very significant
P<0.005	highly significant
P<0.001	very highly significant

The *t-test* was used to test the significance of change in the mathematical achievement. Table 4-9 provides a statistical summary of improvements in mathematical achievements for East Senior Primary School Chess Players. While all results were included, those done on very small samples (four or five learners) were underlined and should be regarded with caution.

Table 4-9 East Senior Primary School: Statistical Summary - improvement in mathematical achievements

Improvement in mathematical achievement	**Sample**	**t-test p>**	**Verbal Description**
Chess players presently at Grade 7 vs their Grade 4	12	0.009	very significant
Chess players who were below average learners at Grade 4:			
Presently at Grade 5 vs Grade 4	11	0.017	significant
Presently at Grade 6 vs Grade 4	7	0.019	significant
Presently at Grade 7 vs Grade 4	<u>5</u>	<u>0.075</u>	<u>nearly significant</u>
Matched Pairs: all			
Chess players vs non-players – Grade 5	15	0.404	not significant
Chess players vs non-players – Grade 6	14	0.035	significant
Chess players vs non-players – Grade 7	9	0.007	very significant
Matched pairs: learners that were below average at Grade 4			
Chess players vs non-players – Grade 5	7	0.500	not significant
Chess players vs non-players – Grade 6	7	0.002	significant
Chess players vs non-players – Grade 7	<u>4</u>	<u>0.048</u>	<u>significant</u>

4.2.2 South Senior Primary School

The Chess club at South Senior Primary School had thirty active chess players. The exclusion of Grade 5 learners resulted in a total of sixteen active players; however, one Grade 6 chess player had to be excluded since his Grade 5 marks in mathematics were not available and one Grade 7 chess player was excluded since his matched non-player was found to be a past player. The low number of chess players and the absence of average grade marks resulted in the limited analysis on data collected from the South Senior Primary School. It was not possible to analyse within the whole grade. However, matched pairs analysis was done.

4.2.2.1 Matched Pairs Analysis

Comparison between changes to mathematics achievements for chess players and their matched non-players in South Senior Primary School is presented in Table 4-10

Table 4-10 South Senior Primary School: Matched pairs

Grade	Number of Learners	Group	Average Maths Mark at Grade 5	Average Maths Mark at Present	Difference Between Present and Grade 5 Marks	% Difference Between Present and Grade 5 Marks
6	7	Chess Players	66.9	52.3	-14.6	-21.5
	7	Matched Non-Players	66.6	56.3	-10.3	-15.5
7	7	Chess Players	48.3	56.9	8.6	17.8
	7	Matched Non-Players	48.6	51.7	3.1	6.4

As can be noted:

- at Grade 6, the mathematics achievement for both Chess Players and Non-Players dropped, with far greater decrease for the Chess Players.
- at Grade 7, the average Mathematics mark for both Players and Non-Players improved. The improvement of the Chess Players tested ‘nearly significant’ compared to the achievement of their Matched Non-Players (p=0.099)

As can be seen from Figure 4-3 the majority of the Grade 7 Chess Players achieved higher mathematics marks than their Matched Non-Players.

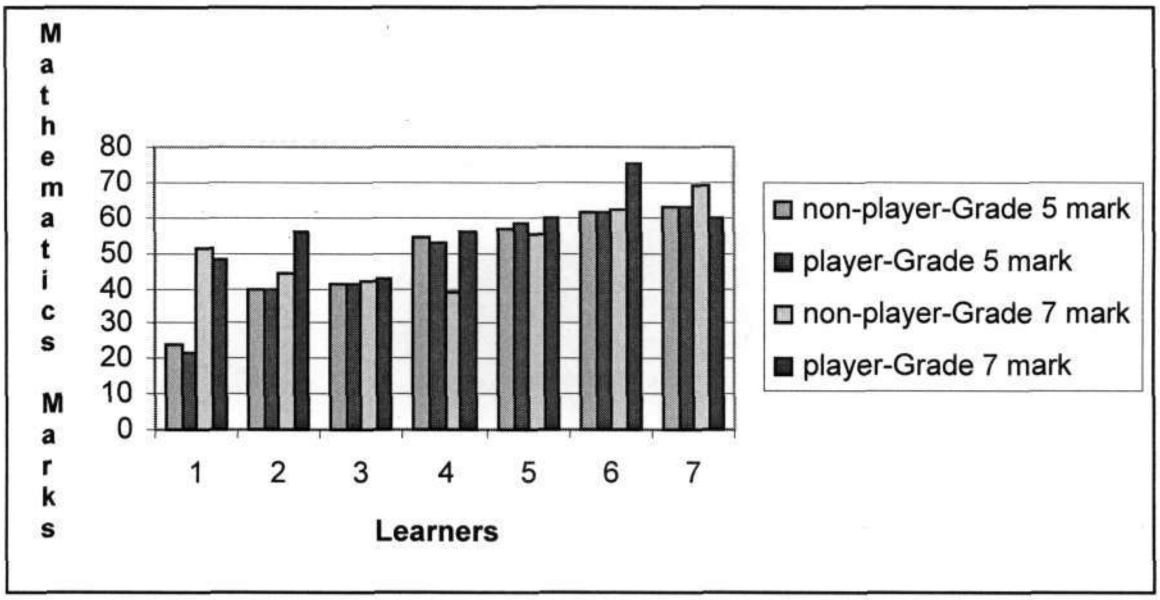


Figure 4-4 South Senior Primary – Comparison for matched pairs of achievements in mathematics - Grade 7 learners

4.2.2.2 Further Analysis

The results for Grade 6 learners were in contradiction to all other results obtained. A further analysis into the detailed data revealed that in Grade 6, the number of female chess players compared to male chess players was unusually high; five out of the seven chess players were females. This research was not aimed to study possible gender related differences in mathematical achievements, however additional gender-based analyses were done. For all the other sub groups analysed, the number of female players was much lower than that of male players, in line with reported numbers (see section 4.2.1.3).

4.2.3 Summary

The above results confirmed the assumption that active chess playing had a positive effect on the mathematic achievements of the players. This effect increased and the gap between the achievements of the players and non-players increased at the higher grade (Grade 7) for both schools. Since more data was available at the East Senior Primary, further analysis could be done. Significant improvement in mathematical achievement was noted at all grades for chess players who were below average achievers in mathematics at Grade 4 and while the weaker learners who played chess improved, the achievements of their matched non-players decreased at the higher grade, increasing the gap between players and non-players.

4.3 RESULTS FOR RESEARCH QUESTION # 2

The second question related to a possible relationship between the amount or level of exposure to chess and the level of improvement in mathematical achievement. Were players who played chess for longer periods and more frequently likely to achieve better in mathematics subsequently to their high exposure to chess? Is there a correlation between the level of exposure to chess and improvement in mathematic achievement? It was clear from the data that grade is not an indicator to the level of exposure since there were learners in Grade 6 and in Grade 7 that started playing chess in the recent year. I defined the criteria for level of exposure as a combination of period played and how frequently the player played during that period. All chess players that participated in the study answered the questionnaire providing answers to the following questions:

- When did you first start playing?
- For how long have you been playing?
- How often do you play?

Answers to the first question were used for validation of answers to the second question. The exposure level was derived for each player using the following translation table:

Table 4-11 Translation table: Level of exposure to chess

Frequency (C2) / Period Played (C3)	Every Day	Few Times a Week	Once a Week	Few Times a Month	Less
More than 2 Years	5	5	4	3	2
1 to 2 Years	5	5	4	3	2
More than 6 Months	4	4	4	3	1
3 to 6 Months	3	3	3	2	1
Less than 3 Months	2	2	1	1	1

A correlation analysis was done aiming to establish whether there was a relationship between level of exposure to chess and changes in mathematical achievement (present grade mathematics mark minus Grade 4 mathematics mark). No relationship has been established since the correlation coefficient between level of exposure to chess and change in mathematical achievement was 0.01 for Grade 5 Chess Players, 0.08 for Grade 6 and 0.11 for Grade 7.

4.4 DESCRIPTION OF PARTICIPANTS

In addition to the above quantitative analysis, all learners who participated in this study answered questions relating to their playing habits and their perceptions about the game of chess. Learners that used to play provided additional information about their reasons to stop playing chess. Summarised results will be presented, highlighting similarities and differences between the groups as well as possible similarities and differences between the two schools.

4.4.1 Active Chess Players

In the following sections, answers to questions C3, C4, C5 and C6 (Appendix B) were analysed. The analysis was done for each of the participating schools (within the school) and a comparison has been drawn between the two schools. The two active chess players from South Senior Primary that were excluded from the Matched Pair analysis sections due to lack of mandatory data, were included in this part of the analysis.

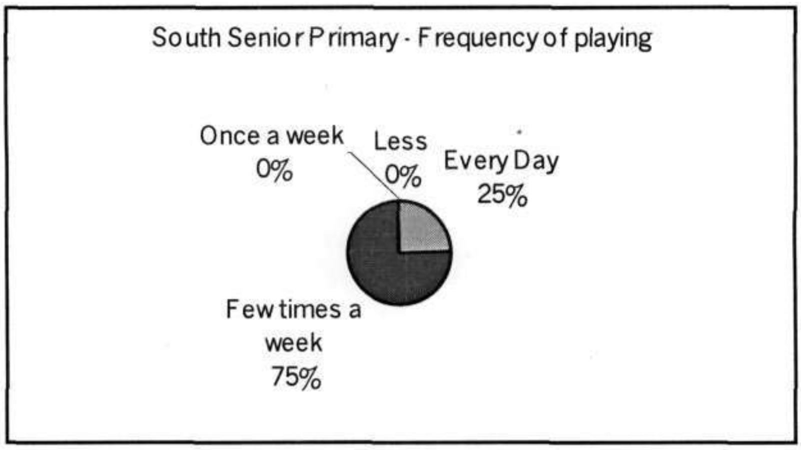
How often do you play?

The frequency of playing chess for learners of both schools is presented in Table 4-12. The majority of chess players at both schools played chess more than once a week.

Table 4-12 East and South Senior Primary Schools: Frequency of playing chess

School	Grade	Number of Learners	Play			
			Every Day	Few times a week	Once a week	Less than once a week
East Senior Primary	5	42	4	30	6	2
	6	22	1	12	3	6
	7	12	1	6	4	1
South Senior Primary	6	8	1	7	0	0
	7	8	3	5	0	0

As further illustrated in Figure 4-5, while all chess players at South Senior primary school played a few times a week and 25% of them played every day, 29% of the players at East Senior Primary seemed to be less committed as they played once a week or less.



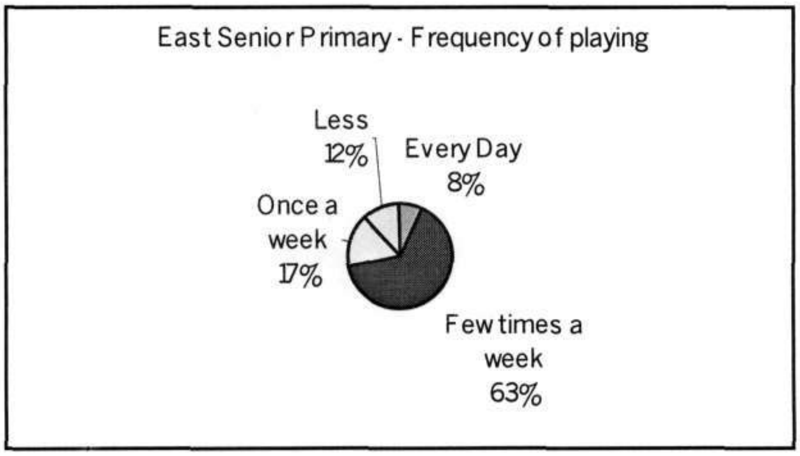


Figure 4-5 - Comparison between learners' frequency of playing between East and South Senior Primary Schools

Where do you play?

Table 4-13 provides a summary of playing venues for players of East and South Senior Primary Schools. The majority of chess players from both schools play mainly at school and at home. Only few of the East Senior Primary players play at clubs but none of the South Senior Primary players played at a club. The main differences can be noted in Grade 7 players' participation in tournaments. While all players from South Senior Primary School played in tournaments, only 33% of the Grade 7 chess players from East Senior Primary played in tournaments. Additional general information, which was obtained from the teachers during their interviews regarding the way the chess school activities operated, provided a possible explanation to the differences between the schools.

Table 4.13 East and South Senior Primary Schools: Playing venues

School	Grade	Number of Players	Play at School	Play at Home	Play at Clubs	Play at Tournaments
East Senior Primary	5	42	36	39	3	16
	6	22	20	20	1	10
	7	12	12	11	0	4
South Senior Primary	6	8	8	5	0	2
	7	8	8	8	0	8

Most tournaments took place during the weekends, in the greater Durban area. While the East Senior Primary players have to arrange their own transport and rely on family to drive them to the venue, John has been providing the transport for players from South Senior Primary that wished to participate. Grade 7 learners being better and more experienced players had priority. This was also a possible explanation to the fact that only two Grade 6 learners played in tournaments.

Who do you play with?

The following table provides a summary for players from both schools regarding their playing companions. The term 'School Mates' was consistently used by most of Grade 7 players at the South Senior Primary School and it referred to learners from other schools that they play against in tournaments and were not necessarily their friends.

Table 4-14 East and South Senior Primary Schools: Playing companions

School	Grade	Number of Learners	Play with			
			Family	Friends	Computer	School Mates
East Senior Primary	5	42	38	41	16	0
	6	22	20	21	6	0
	7	12	9	12	6	0
South Senior Primary	6	8	5	7	0	1
	7	8	1	8	0	7

Learners from both schools played mainly with friends. However, while the majority of learners at East Senior Primary played also with family (88.2%), not so at South Senior Primary School. While 62.5% of Grade 6 learners played with family, only 12.5% of the chess players at Grade 7 (one learner) played with family. The main difference between the schools was playing against the computer. None of the South Senior Primary learners played the computer while the use of the computer as a playing companion for the East Senior Primary chess players was 38.1% at Grade 5, 27.3% at Grade 6 and 50.0% at Grade 7.

Do you think that playing chess helped you in any way with your school work?

In addition to a Yes/No choice, the players were asked to give an explanation to their answer in an open-ended format. While not all players answered this question, some of the players who responded positively, added explanations. These explanations were written in a free format yet all revolved around three main categories; mathematics, concentration and faster thinking. The majority of players from both schools (71.1% at East Senior Primary and 100% at South Senior Primary) believed that chess helped them with their schoolwork. At East Senior Primary only 19.6% of the players mentioned Mathematics as the area where chess helped most while the majority (80.4%) were not subject specific referring to concentration and thinking in general. At South Senior Primary all Grade 7 players believed that playing chess helped their mathematics while the Grade 6 learners split their votes between the three categories. The following table summarizes the answers for learners from both schools:

Table 4-15 East and South Senior Primary Schools: Learners' views - contribution of chess to their school work

School	Grade	Number of Learners	Chess helped in school work			Area in which chess helped		
			Yes	No	No reply	Maths	Concentration	Thinking
East Senior Primary	5	42	29	8	5	6	15	8
	6	22	13	8	1	3	1	5
	7	12	12	0	0	1	4	8
South Senior Primary	6	8	8	0	0	4	5	4
	7	8	8	0	0	8	1	2

Learners were asked to add their comments. Only eight players from East Senior Primary (all from Grades 5 and 6) wrote any comments mostly describing the game as 'fun' and 'cool'. At South Senior Primary Grade 6 players gave no comments yet all Grade 7 learners wrote comments relating to the game being educational and of possible help to their future.

4.4.2 Non-Players

The learners, who did not play chess, were provided with a list of possible reasons for not playing and an option to add their own reasons. Many of the East Senior Primary learners just marked themselves as non-players without providing a reason. A few gave several reasons. Most of South Senior Primary gave reasons for not playing. A summary of all answers is presented in Table 4-16.

Table 4-16 East and South Senior Primary Schools: Reasons for not playing chess

Reasons for not playing chess	East Senior Primary	South Senior Primary
I think it is boring so I never learnt	7	2
I found it difficult to learn	5	7
I was too busy with other sports /activities	8	7
I tried but was no good *	1	1
I just never tried *	5	0

* were added to the list of reasons, based on additional answers provided by learners

Out of those who gave reasons for not playing chess, 31% at East Senior Primary and 41% at South Primary School gave the reason for not playing as 'being too busy with other sports/activities'. While this reason can be identified as a priority choice – the learner chose to play / do other sports / activities, the other reasons are more 'perception' related. Many learners possibly perceived the game of chess as 'boring' and / or 'difficult'. However the data collected was limited since this was not the main focus of the study and did not provide sufficient information for further assumptions.

4.4.3 Past Players

It was of interest to find out why did learners that used to play, stopped playing. Since only one past player was identified at the South Senior Primary Table 4-17 is a summary of data for the East Senior Primary Past players only.

Table 4-17 East Senior Primary School: Reasons to stop playing chess

Reason given by learner	Number of answer
I thought it was boring	4
I found it difficult to play	1
I was too busy with other sports / activities	12
I was never winning	2
I had no one to play at home	4

The main reason provided by learners was 'being busy with other sports / activities'. Since learners had to choose between the various sports as per the school's timetable, chess was possibly losing out to more popular sports.

4.5 SUMMARY

The results provided confirmation to the assumption that playing chess has a positive effect on mathematical achievement of active chess players at Senior Primary School. While the data collection was done at two schools, some data was not available in one of the schools resulting in part of the analysis done on data of one school. For both schools, the following was found:

- the mathematic achievement of active chess players improved significantly at Grade 7 compared to their achievements at entry year.
- the mathematic achievement of active chess players improved significantly at Grade 7 compared to the mathematic achievements of their matched non-players.
- no correlation was found between the level of exposure to chess and improvement in mathematical achievement.
- the majority of the learners believed that playing chess contributed to their school work.

- most of the learners that never played did it because they preferred other sports and activities.
- most chess players have been playing mainly 'social' games, at school and at home with their friends and family members.

Further results were specific to the East Senior Primary School as following:

- active chess players that were below average mathematics achievers at Grade 4 improved significantly their average mathematical achievement at all grades compared to their matched non-players.
- while the improvement of the weaker learners that played chess increased by grade, the average mathematical achievement of the matched non-players decreased by grade, and was the lowest at Grade 7.
- past players were on average better than the average learner at Grade 4. However, their average mathematics achievement decreased at the higher grades.
- most of the learners that stopped playing did it because they preferred other sports / activities.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The study focused on two main questions: was mathematical achievement affected by playing chess and was there a relationship between the level of exposure to chess and mathematical achievement. Two senior primary schools from different socio economic environments, both schools with active chess players were chosen. The chess players were identified and their mathematics marks were retrieved from schools' records: entry year mark and the current mid-year mark. Matched non-players were found for all of the chess players at South Senior Primary and most of the chess players in East Senior Primary. All learners that were chosen to participate in the study completed a questionnaire providing information about themselves; whether they were playing chess, when they started, for how long, how often, with whom and where. Analyses were done for learners in each school, and wherever possible, results were compared.

The improvement was measured by either the change in the present average mathematic marks for chess players compared to their entry year average mathematics mark or by comparing present average mathematics marks of chess players to their matched non-players. At East Senior Primary School, Grade 7 chess players improved their mathematical achievement significantly compared to their own achievement at Grade 4.
The most significant outcome of this study relates to the effect of playing chess on the weaker learners at the East Senior Primary School. This analysis could not be done at the South Senior Primary due to lack of grade average data, which is essential to enable determining who is below average. The average mathematical achievement of the chess players that were below grade average at Grade 4, improved at all grades. However, the average mathematical achievement of their matched non-players declined for Grades 6 and Grade 7. At both schools, Grade 7 chess players' achievement was significantly higher than that of their matched non-players. A direct comparison between results achieved in this study and results reported in other quantitative studies (Christiaen,1976; Van Zyl, 1991; Ferguson, 1995), was not possible.

Van Zyl's study confirmed an improved performance in mathematics starting at Grade 8 – which is out of the age range of this study. She does not report on differences in achievements between various types of learners, i.e. low achievers. Ferguson's study with gifted learners was conducted on learners older than the learners that participated in this study. His youngest were Grade 7 learners. Since this study did not go beyond Grade 7, it is impossible to conclude whether there would have been further improvements in the higher grade.

No correlation was found between the level of exposure to chess and improvement in mathematical achievement. While several related studies focused on relatively high level or experienced players (Horgan, 1987, Van Zyl, 1991) the 'level' of playing chess was not obtained in this study and thus not linked to exposure. Exposure to chess is a combination of the period the chess player had played chess and the frequency played during that period. It does not indicate whether a player that had high exposure was a better player than a player with a lower exposure. Hence, no conclusions should be drawn about possible relationship 'level' of playing chess and achievement in mathematics. Active playing in itself appeared to have the positive effect on mathematical achievement, as there was no improvement for those who stopped.

Many of the chess players believed that playing the game developed their concentration, their thinking skills and their ability to 'do' mathematics faster and contributed to the improvement of their school work. However, most learners that never played or stopped playing gave the reason for them not playing as 'too busy with other sports / activities', indicating preference of other sports. The results of this study, while mainly pointing to the positive effect of playing chess on the mathematical achievements at the highest grade at the Senior Primary level, further reinforced outcomes of other studies relating to the contribution of chess to mathematical ability and achievements

5.2 RECOMMENDATIONS

- Based on the findings, two main recommendations are made. Firstly, that further research in this area is commissioned and secondly, that attempts be made to incorporate chess into the school curriculum.

Since this study was conducted at Senior Primary Schools, and the most positive results were obtained for the last grade at Senior Primary - Grade 7 it is likely that further research at High School level will enable it to be established whether the positive effect of playing chess on mathematics achievement is maintained in the higher grades. Further attention should also be given to research focusing on the weaker learners since the results of this study cannot be generalized given that they come from only one school.

However, the indication that chess can be used to improve mathematical achievements of weaker learners is a significant motivation for the possible future incorporation of chess into more schools extra-curricula activities. The selection of schools that have active chess clubs as venues for further research is one practical option. However, another option will be setting up and conducting studies at schools that have no existing chess activity. While introducing chess into these schools, studies can be done in a controlled pre-test post-test environment. This can be combined with the incorporation of chess into the school extra-curricula activities. This type of study will have to done over several years and will require funding and dedicated facilitators.

In addition it is strongly recommended that chess be introduced to the majority of learners at Senior Primary Schools either through incorporation into the school curriculum or as an extra curricula activity. This study gives strong evidence that chess could be used as one of the tools to increase learners' achievements.

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APPENDIX A An example of a data spreadsheet

This is an example of matched pairs

Lnumber	Name & Surname	School	PrGrade	Status	Gender	Exposure	PP	Frequen	Matched	G4Mark	PrMark	G4Aver	PrAver
2		1	5	P	f	2	2	2	59	38	65	72	75
12		1	5	P	m	3	2	3	69	61	79	72	75
16		1	5	P	m	2	2	2	73	62	55	72	75
23		1	5	P	m	3	2	3	80	63	70	72	75
15		1	5	P	m	1	1	2	72	64	67	72	75
14		1	5	P	m	1	1	3	71	70	63	72	75
149		1	5	P	m	4	3	4	155	71	80	72	75
24		1	5	P	m	4	3	3	81	76	89	72	75
83		1	5	P	m	4	3	3	160	76	91	72	75
28		1	5	P	m	4	3	3	85	77	86	72	75
1		1	5	P	m	4	3	3	58	80	67	72	75
153		1	5	P	f	4	3	3	154	80	76	72	75
27		1	5	P	m	3	2	3	84	86	65	72	75
4		1	5	P	m	3	3	3	61	87	94	72	75
9		1	5	P	m	4	3	4	66	90	79	72	75
43		1	6	P	m	1	3	1	100	40	67	72	71
46		1	6	P	f	3	2	3	103	47	61	72	71
45		1	6	P	m	3	2	3	102	59	61	72	71
44		1	6	P	m	3	2	3	101	61	69	72	71
36		1	6	P	f	1	3	1	93	67	76	72	71
35		1	6	P	m	1	3	1	92	70	69	72	71
42		1	6	P	m	3	2	3	99	72	78	72	71
37		1	6	P	m	4	3	3	94	74	79	72	71
47		1	6	P	m	4	3	3	104	74	79	72	71
32		1	6	P	m	3	3	2	89	77	70	72	71
29		1	6	P	m	4	3	3	86	87	82	72	71
40		1	6	P	m	1	3	1	97	89	73	72	71
30		1	6	P	m	4	3	3	87	91	93	72	71
38		1	6	P	m	1	2	1	95	96	72	72	71
52		1	7	P	m	1	1	1	109	53	49	73	72
53		1	7	P	f	4	3	3	110	54	86	73	72
55		1	7	P	m	2	2	2	112	69	90	73	72
51		1	7	P	m	4	3	4	108	71	66	73	72
54		1	7	P	m	4	3	3	111	80	94	73	72
157		1	7	P	m	4	3	3	114	81	94	73	72
148		1	7	P	m	4	3	3	116	84	86	73	72
48		1	7	P	m	3	3	2	158	91	92	73	72
56		1	7	P	m	1	1	3	113	93	95	73	72
59		1	5	N	f				2	44	58	72	75
69		1	5	N	f				12	63	60	72	75
72		1	5	N	f				15	65	55	72	75
73		1	5	N	m				16	65	70	72	75

80	1	5	N	m	23	66	83	72	75
71	1	5	N	m	14	70	83	72	75
155	1	5	N	f	149	71	70	72	75
160	1	5	N	m	83	75	72	72	75
81	1	5	N	m	24	77	94	72	75
85	1	5	N	m	28	77	52	72	75
58	1	5	N	m	1	80	77	72	75
154	1	5	N	f	153	81	75	72	75
61	1	5	N	m	4	88	91	72	75
66	1	5	N	m	9	89	91	72	75
84	1	5	N	m	27	89	80	72	75
100	1	6	N	m	43	40	51	72	71
103	1	6	N	f	46	47	53	72	71
102	1	6	N	f	45	59	54	72	71
101	1	6	N	f	44	60	61	72	71
93	1	6	N	m	36	68	60	72	71
92	1	6	N	m	35	72	63	72	71
99	1	6	N	m	42	72	54	72	71
104	1	6	N	m	47	73	61	72	71
94	1	6	N	m	37	74	88	72	71
89	1	6	N	m	32	77	56	72	71
86	1	6	N	f	29	88	79	72	71
97	1	6	N	m	40	90	85	72	71
87	1	6	N	m	30	91	85	72	71
95	1	6	N	m	38	95	90	72	71
109	1	7	N	m	52	54	43	73	72
110	1	7	N	f	53	54	46	73	72
112	1	7	N	m	55	69	36	73	72
108	1	7	N	f	51	71	55	73	72
111	1	7	N	m	54	81	73	73	72
114	1	7	N	m	157	81	74	73	72
116	1	7	N	m	148	85	81	73	72
158	1	7	N	m	48	89	87	73	72
113	1	7	N	m	56	94	90	73	72

Key

Lnumber	- Learner's number, unique for each learner	
Name & Surname	- Learner's name and surname (were blanked to maintain confidentiality)	
School:	1	East Senior Primary
	2	South Senior Primary
PrGrade	- Learner's present grade	
Status:	P	Active Chess Player
	N	Non-Player
	E	Used to Play Chess
Gender:	m	Male
	f	Female
Exposure:	- a combination between Period played and Frequency of playing	
	1	low
	2	medium
	3	high
	4	very high
PP:	- Period Played	
	1	less than 6 months
	2	between 6 months and 2 years
	3	more than 2 years
Frequen:	- Frequency of playing	
	1	less than once a week
	2	once a week
	3	few times a week
	4	every day
G4Mark	- learner's Grade 4 mathematics mark	
PrMark	- learner's present grade mathematics mark	
G4Aver	- Grade 4 Average mathematics mark	
PrAver	- Present Grade Average mathematics mark	

School: ________________ Grade: ____ Name ______________________

A 1. Do you know how to play chess ?

Yes
No

If the answer is **NO**

1.1 Why not ? (you can tick more than one block and add your reason)

- [ ] I think it is boring so I never learnt to play.
- [ ] I found it difficult to learn
- [ ] I was too busy with other sports / activities
- [ ] I tried but ______________________________
- [ ] Other reason ____________________________

Thank you for answering , please hand this paper back to your Teacher

If the answer is **YES**

If you are playing chess now

Please **turn** the page and answer the questions in section labeled **C**

If you used to play chess **BUT** do not play anymore

Please continue to answer the questions in section labeled **B**

B **I USED TO PLAY CHESS**

1. When you played, how often did you play? (tick only one block)

- [ ] Every day
- [ ] A few times a week
- [ ] Once a week
- [ ] Few times a month
- [ ] Other ______________________________

2. When did you stop? (tick only one block)

- [ ] This year
- [ ] Last year
- [ ] More than two years ago

3. For how long did you play before stopping ? (tick only one block)

more than 2 years	1 to 2 years	
more than 6 months	3 to 6 months	less than 3 months

4. Why did you stop playing? (you can tick more than one block)

- [ ] I thought it was boring
- [ ] I found it difficult to play
- [ ] I was too busy with other sports / activities
- [ ] I was never winning
- [ ] Other reason ________________________

5. Who were you playing with? (you can tick more than one block)

- [ ] Family
- [ ] Friends
- [ ] Other ______________________________

6. Where did you play ? (you can tick more than one block)

- [ ] School
- [ ] Home
- [ ] Club
- [ ] Tournaments / Competitions
- [ ] Other ______________________________

Thank you for answering , please hand this paper back to your Teacher

C I PLAY CHESS NOW

1. When did you first start playing? (tick only one block)
   - [ ] This year
   - [ ] Last year
   - [ ] More than two years ago

2. For how long have you been playing? (draw a cross on the block)

more than 2 years	1 to 2 years	
more than 6 months	3 to 6 months	less than 3 months

3. How often do you play? (tick only one block)
   - [ ] Every day
   - [ ] A few times a week
   - [ ] Once a week
   - [ ] Few times a month
   - [ ] Other ______________________________

4. Where do you play ? (you can tick more than one block)
   - [ ] School
   - [ ] Home
   - [ ] Club
   - [ ] Tournaments / Competitions
   - [ ] Other ______________________________

5. Who do you play with ? (you can tick more than one block)
   - [ ] Family
   - [ ] Friends
   - [ ] Other ______________________________

6. Do you think that playing CHESS helped you in any way with your school wor
   - [ ] Yes
   - [ ] No

   Explain your answer:

   ____
   ____
   ____
   ____
   ____
   ____

Do you want to make any comments ______________________________
____
____

Thank you for answering , please hand this paper back to your Teacher