THE UTILIZATION OF CHESS TO ENHANCE CHILDREN'S ACADEMIC PERFORMANCE: AN INTEGRATIVE REVIEW

by

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Abstract

Anecdotal evidence affirms the educational benefits of playing chess. I present an integrative review based on the framework of Whittemore and Knafl (2005), which analyzes the literature on chess and strategic gaming. This review indicates that primary and secondary educational researchers who use chess and strategic gaming in classrooms have published critical evaluations of learning and teaching theory based on their studies. While the use of chess in education is commonplace in some educational jurisdictions, the majority of Western school systems have not integrated this practice into their curricula. Conflicting evidence has been reported on the benefits of strategic gaming, in particular chess. This structured methodology for reviewing literature takes into account all stakeholders and assesses the usefulness of chess for meeting the needs of a 21st century educational system.

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Chapter 1 – Introduction

In the practice of public education, Alberta's department of education, the superintendents of schools, and parents concerned with the cognitive abilities of their children often connect with teachers. Frequently, parents and authorities compare students and question whether their children or students are better or worse than others (Serbessa, 2006). When attempting to meet the needs of students, teachers are caught in a difficult position of justifying the implementation of strategies that use technology, differentiated instruction, 21st century learning approaches, and other alternative educational practices. All concerned individuals expect teachers to respond informatively to inquiries about children's success, but it is still uncomfortable for many educators to be placed in these situations.

Background

According to the Alberta Teachers Association (ATA), teachers have a responsibility to keep abreast of new developments in education and to continue to develop their professional practice. The Council on Alberta Teaching Standards (COATS) concurs and describes professional practice as encompassing knowledge in subject areas, having skills to make complex decisions, using techniques and resources for promoting learning, and performing assessments and evaluations that monitor progress.

One could argue that Alberta's reaction to student learning and achievement has changed dramatically from the traditional, stand-and-deliver mode of pedagogy that was used for the better part of the 20th century. Generally stated, pedagogy refers to strategies of instruction, or best methods, that allow students to analyze, interpret, and predict new information. Pedagogically, Alberta's teachers are now expected to use many different modes of learning to accommodate the 21st century learner (Alberta Education, 2009b). Technology is just one of the

many strategies that support student engagement and, hopefully, achievement. This constructivist pedagogy can be seen as incorporating many different modes of learning that are not wholly recognized as quantifiable but still worthy of inclusion in the classroom. Given the professionalism affixed to teachers in Alberta, a dimension of autonomy allows teachers to find various educational paths to success for the students in their charge. This means that spectrums of instructional practices are available for teachers to implement in their classrooms.

Standard, or traditional, educational practice is a term that covers a broad range of philosophies, approaches, methods, and teaching styles that are made available in almost all educational jurisdictions. Beyond health and safety issues, the acquisition of basic skills, especially in the areas of literacy and numeracy, are linked to local, provincial, and national goals. Standard education is a priority in almost every low- and middle-income country (Serbessa, 2006). However, alternative education strategies are often employed by high-income nations. Depending on the philosophical bent, computer technology, 21st century learning, and strategic gaming have been provided by a diverse group of educators with distinctive educational backgrounds and an assortment of professional credentials.

These supplemental educational experiences have become increasingly studied over the past decade as developed nations vie for status and future economic stability. The results of the Program for International Student Assessment (PISA), a detailed comparison of 74 nations' educational systems, are reviewed yearly by the Organization for Economic Cooperation and Development (OECD). The use of alternative educational programming has been very common in many top-performing nations such as Canada, Finland, Singapore, and Japan and is influenced by their value systems and cultural beliefs. As revealed in the work of Ron Miller (2004), even in

the have and have-not educational jurisdictions of the United States, the use of alternative educational programming is popular.

In the ever-changing world of education, parents, students, and schools often use alternative educational practices when dissatisfied with the effectiveness of standard educational approaches or when trying to engage students and increase their achievement levels. As stated in the pilot project initiated by the Ontario government for increased high school completion rates, *Strategies for Students Success*, the program serves specific student populations, "whose difficulty in succeeding in the traditional school environment relate to particular social or cultural needs" (Ontario Ministry of Education, 2005, p. 2). Students use alternative education when coping as homeless youth, Aboriginal students, youth from lower income backgrounds, and students learning English as a second language (ESL). These patrons do not reject traditional education as such, but use alternative education to complement the traditional education provided (Alberta's Commission on Learning, 2003; Ontario Ministry of Education, 2005; Vancouver School Board, 2011).

Does Chess Make Better Students?

Even though many researchers have shown a correlation between a student's educational success and the playing of chess (Allen & Main, 1976; Dauvergne, 2000; Liptrap, 1999; Marguilies, 1992; Squire, 2003), chess has only been used sporadically by school jurisdictions to attempt to enhance student achievement. Remarkably, the playing of chess seems to correlate most strongly with improved student behaviors and attitudes (Dauvergne, 2000; Tully, Dunn, & Hlawaty, 2006; McDonald, 2009). These improvements coincide with several primary objectives that are found in Alberta's Guide to Education; that is, students "demonstrate desirable personal characteristics, such as respect, responsibility, fairness, honesty, caring ... demonstrating critical

and creative thinking" (Alberta Education, 2009b). As a part of constructivist pedagogy, chess's efficacy seems worthy of study.

It is also worth noting how efficacy will be interpreted throughout this research. Efficacy will be recognized as it is found in Merriam-Webster's Collegiate Dictionary: "the power to produce an effect." For this research, the power to produce an effect can be seen in the pronouncement issued by Alberta Education (2007a), where "student engagement and success in high school" (p. 1) is seen as a next step in improving student achievement levels. If chess can be shown to have a measure of efficacy because of its use within the school setting, then it should be considered a reasonable addition to sound constructivist teaching practice. However, only a few student-centered chess programs presently exist in Alberta (Thomas, 2009), and most of these are extracurricular in nature. Other provinces, such as Quebec and New Brunswick, have placed chess into their curriculum (McDonald, 2009). Despite the fact that chess is a worldwide phenomenon, most of the research reported in this review will come from first world nations, which gauge their students' achievements through similar forms of standardized testing. Most often, Canadian, American, and Western European sources will be cited. The struggle to increase student achievement is not a uniquely regional or Alberta phenomenon; it is at the core of every nation's economic policy. Children are expected to mature and replace the next generation of aging workers.

With this in mind, the focus of this project will be to determine the practicality of utilizing chess to increase the educational achievement of students. This project will use an integrative review methodology to gauge the effectiveness of using chess as an alternative educational practice. Through this study there will be an opportunity to clarify the issues that impact teaching practice across Alberta and to improve upon processes for addressing such

issues. This project will attempt to critically appraise and synthesize primary research published in the field and to contribute to the scientific knowledge base. To guide the reader through this project, there will be six chapters: (1) Introduction; (2) Problem Identification; (3) Methodological Approach and Stages; (4) Integrative Literature Review; (5) Synthesis of the Research and Data Interpretation; and (6) Conclusions and Recommendations.

Chapter 2 – Problem Identification

In the ever-adaptive world of education, a number of traditional and alternative educational modalities, such as the Alberta Initiative for School Improvement (AISI), have been used to engage students in the process of enhancing learning. The integration of computer technology and interactive whiteboards are typical examples of recently accepted alternative educational undertakings (Armstrong, et al., 2005). Strategic gaming, in particular chess, has long been touted as an avenue to higher cognitive ability, and has been implemented in select schools in Russia, the United States, Canada, and Argentina (Celone, 2001b; Dauvergne, 2000; Drummond, 2000; Liptrap, 1999).

In the current research-based state of education, teachers are encouraged to review literature, yet there is a limited availability of comprehensive literature that attempts to explain if strategic gaming influences the educational success of students. It would be valuable to rely on a systematic review method that has a comprehensive analysis as its universal standard. Many believe that critical thinking skills, memory, and attention are concepts that figure strongly along with playing chess, and that those concepts are a possible explanation for the overall effects of strategic gaming on education enrichment and students' problem-solving abilities (Liptrap, 1999). According to standard educational practices, the effects of chess playing may be attributed to inter-domain transfer, where problem-solving skills in one area of learning could be applied to another. An alternatively held belief is that strategic gaming and chess may work to promote self-esteem after prolonged exposure. For perceptually impaired students, the controlled exposure to chess is thought to impart appropriate behaviors, which garner lasting effects (Forrest, et al., 2005). The use of a systematic review method that has as its universal standard a

comprehensive analysis or integrative review procedure would be useful to educators making classroom decisions about incorporating chess into their yearly plans.

The Alberta government suggests that a balanced approach to social-emotional and cognitive development will best prepare all students for future success (Alberta Education, 2009a). This balanced approach seems to support the evidence collected by the Scottish Aberdeen Chess Development Project. Poor behavior at school, disillusioned learners, and poor parental involvement could be changed with the introduction of strategic gaming into a school district's curriculum (Forrest, et al., 2005). Aberdeen Community Learning and Development manager Pete Hamilton believes that chess has improved students' behaviors at school. These interpersonal factors include healthy and wanted behaviors. However, this does not explain adequately why others theorize that students' cognitive abilities seem to be enhanced (Liptrap, 1999).

Strategic gaming is classified as having a lack of random elements or chance and seems to require higher decision-making skills. Typical examples of strategic gaming are chess, Sim City, and Go. Examinations of the most popular theory among chess researchers seem to demonstrate that chess programming correlates significantly with an increase in standardized test scores (Forrest, et al., 2005; Liptrap, 1999). The cognitive development theory suggests that neural pathways are strengthened by increased strategic game playing. When this type of stimulation occurs, it appears to affect the mind's ability to strengthen neural pathways. Others theorize that faster and smoother communication between linked areas of the brain provides more processing power. Chess is believed to be one means of stimulating the growth in neural connections, as seen in dendrite growth, an increase in the brain's surface area for receiving incoming information (Doidge, 2007).

Doidge (2007), an authority on brain research, is of the opinion that the mind is quite malleable, plastic, and that stimulation of the brain does create new neural pathways. Nevertheless, without enriched environments during infancy and childhood, learning stagnancies can occur and deprive a child's brain of vitality and well-being. These neurological deficiencies are most often the forerunners of reduced student achievement. Due to this lack of resources, many students struggle to reach the same academic levels as those whose lives are enriched (Lacour & Tissington, 2011). Many researchers believe chess stimulates the corresponding neural networks and adds to the ability of the brain to adapt, learn, and retrieve new information (Margulies, 1992; Liptrap, 1999).

Given the large number of chess research studies, it is important to know why some believe that chess has a measurable effect on student learning and why others disagree. Knowledge and understanding of the factors contributing to or impeding students' academic achievements may help educational jurisdictions assess the worthiness of including chess in the fold of recognized alternative educational practices. This is especially important today, when some school districts implement well-intentioned practices, such as longer school days in combination with traditional teaching practices, only to realize insignificant gains in students' achievements (Yeh, 2011).

This research will help to clarify the current practice of using chess as an alternative educational modality. In the exercise of teaching children, research and practice form an important partnership that expands the knowledge base of teaching that yearns for verifiable evidence. This review is compelling in that it should provide evidence for determining what areas of strategic gaming, in particular chess, may need further consideration and whether additional exploration of this topic should be completed. Moffett (2000) argues that an effort

should be made by policy makers and school districts to study the body of knowledge that presently exists because there is enough research for them to act more strategically. There needs to be an abundant supply of research to sustain the next level of educational change taking place.

Chapter 3 – Methodological Approaches and Stages

Integrative Literature Review

The research method utilized in this project will be an integrative literature review. The organization of carefully investigated research studies can present connections between best practices and research (Cooper, 1984; Polit & Beck, 2008). The rationale for an integrative review is that it is the broadest type of literature review, and it advances the discipline by accumulating past investigations (Torraco, 2005; Whittemore & Knafl, 2005). Systematic literature reviews are perceived as important methodologies in the "advancement of a discipline, because they accumulate past endeavours, summarize major issues and are an important way to disseminate the information generated by a large number of individual studies" (Evans & Kowanka, 2000, p. 33). An integrative review also allows for the study of a spectrum of research methodologies, including "experimental and non-experimental research" (Whittemore & Knafl, 2005, p. 546) and summarizes past literature to provide a more comprehensive view of a particular trend. Therefore, both quantitative and qualitative research studies can be assessed for a more complete appraisal of data. Quantitative data and results provide a general picture of the research problem, while qualitative data and analysis filter and explain the statistical results by investigating research subjects in more depth (Creswell, 2002; Teddlie & Tashakkori, 2003). Integrative reviews have the potential to build informing research that can facilitate the development of educational "practice and policy initiatives" (Whittemore & Knafl, 2005, p. 546).

However, the synthesis of data from a variety of sources is complicated, affecting both bias and accuracy. The framework that I have chosen to follow consists of the problem formulation stage, literature search stage, data evaluation stage, data analysis stage, and presentation of results stage. The works of Beck (2008), Whittemore and Knafl (2005), and

Garrard (2007) were used to advance the data collection process. Articles were coded for applicability, survey frame, procedures, and data analysis.

This section will describe each of the five steps of the integrative review in more detail to emphasize the process and thoroughness applied to the project and the findings.

Problem Formulation

Developing a clear problem is the initial step in the integrative review process. In this instance, the determination of the value of using chess as a recognized alternative teaching practice is the problem. Teachers in Alberta use alternative educational modalities to increase students' engagement and, optimistically, their cognitive abilities. Alternative educational practices are often encouraged each year through government initiatives, professional development seminars, and conventions.

Achievement factors refer to the cognition of intelligence, as it is associated with student testing and the measurable improvement in their ability to synthesize information. Conversely, interpersonal factors include the circumstances that increase the likelihood of engaging in perceived healthy and wanted behaviors (Alberta Education, 2007b). The inspiration of wanted behavior associates most closely with the Alberta Government's publication, *Administrator's Guide to Raising Alberta's High School Completion Rate* (2009a), which states, "A balanced approach to emotional, social, cognitive, and language development will best prepare all children for success in school and later in the workplace and community" (p. 1).

Research on the study and application of interpersonal and achievement factors recognizes individuality because each person is affected by a spectrum of aptitudes that change over time (Liptrap, 1999). Developments in interpersonal and achievement factors research emerge when studies examine many varied populations and are able to find associations or links

among alternative teaching practices over a specific period of time (Forrest, Davidson, Shucksmith, & Glendinning, 2005; Hong & Bart, 2007).

Since the 1894 publication of Alfred Binet's psychological study on chess and its effects on grand masters' intelligence, achievement, and interpersonal factors associated with the playing of chess, chess has been studied and explained (Holding, 1992). A majority of these publications describe research designs that include the use of sound quantitative and qualitative research methods. Within both factors, one can find categories of research that are associated with cognition, academia, and social order. Consequently, research has focused primarily on grand masters and their specific cognitive development and capacity.

Chess as an alternative educational modality used by students and schools around the world is not well known among educators in Alberta; therefore, it can and should be evaluated and investigated through its varied research. The focus of this integrative review is to answer these questions:

1. How effective is the integration of chess into a school's curriculum, described in the literature between 1965 and 2013?
2. What frameworks were used to guide the practice of integrating chess into the classroom?
3. What recommendations were made for the utilization of chess as a method of enhancing the educational aptitude of students?

Literature Search

I searched for articles that reported observed research. Within the research topic, chess and strategic gaming, I assessed previous circumstances and searched for linkages with students' achievement. The articles were written in English, employed quantitative and/or qualitative

methods, and were published in peer reviewed journals. To ensure a methodical search for both older and current published research, a two-step process was utilized.

A search of literature using the ERIC (1965 to present) and SAGE (1971 to present) databases was conducted during the spring of 2013. This was followed by a search of the ProQuest K–12 (1980 to present) database and Google Advanced Scholar for supplementary articles. The key words used in the search included *chess*, *education*, *children*, *communication skills, team building, conflict resolution, cognition, achievement,* and *intelligence.* This search focused on primary studies, and it initially revealed 76 English-language articles. Of these, eight articles met the inclusion criteria. These articles were cross-referenced for missing research, which resulted in an additional two articles that met the criteria. Therefore, there were a total of 10 articles centering on chess and strategic gaming included in the "sample" for this literature review. Articles that focused on adults, computer models, gaming algorithms, position memory, or chess-piece placement were removed from the research sample. Finally, each article was coded for theoretical importance using Whittemore and Knafl's (2005) rating criteria.

Data Evaluation Stage

There are two important steps in data evaluation for an integrative review. First, each article needs to be critiqued to evaluate its worth. The second step is the summary and synthesis of each selected article. One main interest in this type of review involves assessing the methodology used, and to logically evaluate whether chess transfer to student's interpersonal and achievement aptitudes takes place. The intention is to extract the breadth of research for common data, all the while reducing error. I have refrained from discussing the statistical means for substantiating results, but an alpha level of $p < .05$ is the standard used for behavioral sciences. The term significance will only be used to describe the statistical data found in the reviewed

studies. Even though many different types of research were selected, the research quality of each article has been evaluated for validity, reliability, bias, and appropriate methods (Whittemore, 2005). Whittemore (2001) provides details into the rubric for the scoring criteria of quantitative research, which includes:

- sample: size, description, and presence of rational inclusion and exclusion criteria;
- protocol or intervention: systematic and well explained, detailed enough to understand what treatment intervention took place, whether subjects were blinded or randomized, and discussion about group comparisons is evaluated;
- measurement: data collection tools are well explained, allow for reliability and validity, and any threats to validity are explained;
- attrition: if any participants are not included in the study results the researcher explains their absence;
- statistical analyses are well explained and the alpha level is reported with accurate assumptions; and
- discussion: the conclusions are well explained and any weaknesses, such as bias, are discussed.

The criteria for evaluating qualitative research are somewhat different. As noted by Polit and Beck (2008), they include:

- a clear statement of the problem, research question, sample origin, qualities, and sample size;
- a logical and well-researched literature review;
- central concepts that are clearly explained and defined;
- methodological considerations such as complete sample and setting descriptions,

the protection of participants' rights, appropriate research designs and analyses;

- data collection is well described;
- data analysis strategy is clearly defined; and
- findings, interpretations, and implications are articulated.

Inclusion and Exclusion Criteria

Regrettably, there is no gold standard assessment tool made available for the evaluation of research within the configuration of the integrative review. Nevertheless, I have used a format or approach that allows for a spectrum of the research literature to be viewed from an equitable perspective. Therefore, I have chosen the Inclusion and Exclusion Criteria framework of Whittemore et al. (2001) to critique the studies. Single points have been granted for studies that comprehensively answered each question laid out by Whittemore. Half points have been awarded for questions that were addressed by the research but only in a partial way. Any research studies that received a low score have not been barred from data analysis but have been treated as having less relevant as compared to their counterparts. Generally, the research has been categorized by a total score out of 10, and rated as having lower relevance (1–3), moderate relevance (4–7), or higher relevance (8–10) (Whittemore et al, 2001, p. 530).

Delimitations and Limitations

While this paper offers an opportunity to explore the practice of teaching from an alternative perspective, there are limitations in available data. This research provides only a single perspective on the effects of chess in school-age children as it relates to academic achievement and social skills. Ideally, it would have been best to have two independent reviewers using coding techniques to organize data. If done properly, the level of agreement could have been better controlled by a well-designed scoring mechanism.

It would have been best to have all associated research on the topic incorporated into this integrative review (Jadad et al., 1998), but the convenience sampling is biased towards research written in English; therefore, the study cannot say with confidence that the sample was completely representative of the topic. As a result, there are limitations in the generalizability of the report's findings. Many computerized databases have been used for their convenience and effectiveness of gathering research. Incompatible search terms and multiple strategies for the listing and categorization of databases limit this study's accuracy to some extent. Whittemore and Knafl (2005) believe that only 50% of applicable studies are usually found through primary computer searches.

By exploring a more holistic perspective, including both achievement and interpersonal effects of chess education, there is variability for how the data have been categorized and identified by one person. It is reasonable to argue that a consistent approach to reviewing could be attained, but it may also be argued that the potential for bias increases with only one researcher.

Chapter 4 – Integrative Literature Review

In this section, the research studies have been categorized as having high, medium, and low relevance. A brief description of the studies is provided, followed by a summary of the group as a whole. An overview of chess studies that meet the inclusion criteria (Appendix A) will display a general statement of these conclusions. Those articles not accepted (Appendix B) outline a portion of the research undertaken, but no value is attached to their relevance.

Studies That Rated High in Relevance

These are the three top studies that examine the relationship between the playing of chess or strategic games and students' success in school. All were rated as having a high level of relevance (between eight and 10 points).

Hong and Bart (2007). In the article "Cognitive Effects of Chess Instruction on Students at Risk for Academic Failure" (2007), the authors research the effects of chess education on students with learning problems. The authors contended that there was no discernible effect on students' abilities; however, there was a concern that the students needed more time playing chess if the researchers wanted to add a further level of thoroughness to their findings.

The researchers used a strong experimental design for completing the investigation. Pretests were used to equitably separate subjects into control and experimental groupings. There was no discernable difference found between the two groups based on the one-way analysis of variance. Performance bias could have been an issue affecting the study because of the pretesting and ethical approval. The students and parents knew they were a part of a research study. A more persuasive research model could have included a third grouping for the inclusion of an alternative educational experience. This might have eliminated the possibility of an experimental effect. Nevertheless, the researchers began their investigation with a limited number of students

to investigate. Any further subdivision would have only reduced an already limited internal validity.

Hong and Bart (2007) used a convenience sample of thirty-eight students (n=38), grades 3 to 6, from two primary schools in Korea. The chess group received 90 minutes of chess lessons once a week for three months. Chess instruction consisted of theory, review, and chess play. The tests consisted of the Korean Basic Skills Test (KBST), the Raven's Progressive Matrices test (RPM), which measures nonverbal abilities and perceptions of geometric figures, and the Standard Progressive Matrices test (SPM). Chess skill was measured using the Chessmaster 9000 rating scale. The students were then retested using the TONI-3 and RPM tests. These measures acted as dependent variables for the final statistical analysis.

This study had several good features. Pretests and posttests were multifaceted and thorough, children were randomly allocated to control and experimental groupings, and the researchers were separated from the teaching of chess and testing. The study had an adequate sample size, and many checks were set in place to maintain validity.

There was a partial correlation of data between chess skill rating and controlling for pretest scores with the TONI-3 test of nonverbal intelligence. Posttests were marginally significant for better chess players, but no reliable effect was found among the tests, or in any of the other testing with the RPM assessment. A common theme within this study is that chess does not support achievement. Even though some students became very good chess players, others continued to play quite poorly.

The researchers believe there are weaknesses in their study. They mention that the allotment of time spent teaching chess could have affected the variable being researched. The questions they ponder are whether an increase in instructional time, and the time spent playing

chess, could make a substantial difference in achievement. Perhaps "one whole academic year and preferably two academic years" (p. 94) may have allowed enough time for more observable learning to take place.

Allen and Main (1976). The second study rating as highly relevant is "The Effects of Instructional Gaming on Absenteeism" (1976). The goal of this study was to investigate the effects of strategic gaming on middle-school students in Detroit's inner city. The authors show that access to a scheduled gaming class does maintain a student's interest and bolsters his or her school attendance. They had an experimental control group design that used the same research teacher for both gaming and non-gaming classes. The researchers hypothesized that students exposed to chess would not show a difference in attendance rates.

Student engagement is typically a combination of psychological and behavioral factors. Students' attitude toward learning is often associated with the term. It is understood that students with poor success rates and lack of engagement with learning were linked with poor attendance (Willms, 2011). The National Center for School Engagement agrees and describes the symptoms of isolation from peers, low self-esteem, unwanted pregnancy, and dropping out as other problems associated with a student's lack of attendance in the middle-school years (National Center for School Engagement, 2007).

Allen and Main's (1976) convenience sample consisted of 57 seventh graders and 23 eighth graders from Pelham Middle School in Detroit. Semester classes were used to assign students to gaming and non-gaming groups. The gaming group received two classes of the Equations game per week, while the control group was given academic review work. Game instruction included tactics and tournament play, and was matched to student ability. The students in the non-gaming class were expected to work independently after being given review

material. This approach is characteristic of a traditional students-to-teacher educational model. Attendance was the dependent variable because there was no pretest or posttest used, and no other measures were controlled.

The authors identified the values of fair play as being essential to the research, with students winning and losing an equal number of times. It is "in this manner that the competitive aspect of the learning situation is (was) carefully controlled" (p. 6). They go on to say that the teachers, X and Y, who were used to implement the Equations programming design, were encouraged to maintain the students' self-confidence.

The researchers provided a background for the integration of Equations, a problem-generating game like chess, into the classroom. When a player makes a choice during the game, he or she immediately constructs a problem for the opposing player. Mathematical ideas were incorporated in such a way that students with better arithmetic capability could construct more complex problems for their opposition.

A consistent effect was found in the control group for first and second semester attendance. Statistically significant effects were found for the students who were involved in the Equations game class, although there was no residual effect for students who attended the gaming class first semester and moved to the control group or regular classes the second semester. The researchers used the Behrens-Fisher statistic, which adjusts for differences in group sizes and variance. The null hypothesis was rejected for absenteeism. In fact, when students had to switch classes halfway through the year, the rate of absenteeism almost doubled.

There were few weaknesses in the study, and it could be argued that bias was evident in the number of students who attended the non-gaming class. The small sample size would have affected the validity. Also, the bias created by having the same teacher for both gaming and non-

gaming classes, and who was aware of the trial, could have consciously or subconsciously acted in response to the pupils and the study. This was most perceptible in the difference found between the two teachers' statistics. Teacher X had a much smaller deviation with attendance issues as compared to teacher Y. But the researchers did not mention this disparity. Finally, I think that any form of experimental control could have been included as an alternate to the independent variable.

Ferreira and Palhares (2008). "Chess and Problem Solving Involving Patterns" (2008) is the third study rating as highly relevant for methodological and theoretical rigor. This quantitative study researched the relationship between problem solving and chess education, looking for connections in geometric and numeric patterns. Within the study of multiple intelligences, it is recognized that skill in organizing geometric shapes and handling long chains of reasoning to make sense of progressions are examples of developed logical/mathematical intelligence (Smith, 2008). Howard Gardner (1999) thought that the best way to assess any of the many forms of intelligence would be to "develop several measures for each type of intelligence" (p. 98). In this study the researchers did just that. They hypothesized that students with the ability to play chess would not have substantial proficiency or enhanced capacity to solve mathematical problems based on patterns as compared to non–chess playing classmates.

Portugal's Department of Basic Education (primary education) promotes the use of strategic gaming in the classroom. The researchers used both a pretest and a survey to begin the study, and rated the chess skill set for each student by using the chess federation's rating system called Elo. Elo is the standard method for calculating relative skill for international chess, soccer, and basketball, as well as American college football and major league baseball.

The authors identified the value of chess found in the literature, which includes themes of academic performance, problem solving, increased memory, concentration, visual spatial abilities, and identification of pattern. Historically, chess players' abilities have been correlated with higher intelligence, but the authors observed that this does not necessarily cause the former, and that there is a "need to discover and clarify the relationship" (p. 250).

The sample consisted of 437 students from third to sixth grade, and these students were assigned to either the control or chess group. The chess group was made up of students that received both school lessons and after-school programming in chess. There seem to be many chess clubs found in the Braga region. Measures for age, years of schooling, gender, and mathematics were included in the assessment for a random sampling of students.

The final application for research was designed for 105 students. The correction criterion for the pretest was based on the work of Charles, Lester, and O'Daffer (1992), and test questions were analyzed using Chronbach's Alpha for internal reliability and validity. The test scorer was confirmed for reliability, and a correlation coefficient, alpha to .01, was attained.

The study tested two hypotheses: (a) Does the playing of strategic games like chess allow students to recognize numeric patterns better than non-players can recognize them? and (b) Does the playing of chess allow students to recognize geometric patterns better than they can be recognized by non-players? In line with the first hypothesis, some of the testing found that the strength of play did have a positive relationship with the problem solving of numeric patterns. Ferreira and Palhares (2008) concluded that the difference in identification of pattern was not meaningful. With respect to the second hypothesis, a comparison of scores on the posttest showed that almost all students discovered geometric patterns more easily than numeric patterns. Therefore, no correlation was discovered between chess and the academic success of students.

In summary, this study has several strengths, including random sampling of students to control the groupings; the use of a survey, pretest, and posttest with a number of standardized measures; and a different support staff undertaking the teaching and testing. The authors accepted that more research needs to take place. There was only one "non-treatment" control group, and I agree with the authors' suggestion that it would have been better to include another strategic gaming class, like Mastermind, which could have been used as a placebo. Given an alternative research group, success garnered through engagement in learning could be measured.

Studies That Rated Moderate in Relevance

These are the five adequately researched studies that examine the relationship between the playing of chess or strategic games and students' success in school. All were rated as having a moderate level of relevance (between 4 and 7 points).

Forrest, Davidson, Shucksmith, and Glendinning (2005). The first study rating as moderately relevant for methodological and theoretical rigour is "Chess Development in Aberdeen's Primary Schools: A study of Literacy and Social Capital" (2005). The authors explored the relationship between chess, interpersonal skills, and academic achievement — described as a nested study. Alberta Education (2007c) agrees; they too want students in elementary schools to become more socially oriented and to "learn to share, cooperate and work together in groups while continuing to build and strengthen their senses of identity and self" (p. 16). Common in theme to the Allen and Main (1976) study, the Forrest et al. study worked with schools that had children living within income support neighborhoods and dealing with a higher than average incidence of non-attendance. The students' attainments of curriculum goals are described as being below the district's norm and compound the community's worries.

The quasi-experimental and ethnographic case study of two elementary schools used chess as a tool for purposeful change. The primary researcher maintained written and photographic observations of all types of chess instruction at Aberdeen's primary schools. Students, parents, and teachers were asked to discuss their impressions of chess integration into the school's list of extracurricular activities during the year of study. Questionnaires, focus groups, and progress reports were all analyzed using a constant comparative method of coding following typical grounded theory practice. The second quasi-experimental segment of the study focused on three grade 4 classes: one placebo, one experimental, and one control. The fraction of gender was controlled for, making ratios of male to female participation almost identical. Informed consent by the parents was gained.

This project, which took place from 2003 to 2004, aimed at providing a stimulating experience fostering children's reading, thinking, and other aspects of learning via chess instruction. Social capital stood out as a valued commodity for this in-school and out-of-school activity.

Forrest, Davidson, Shucksmith, and Glendinning (2005) used four pretests to sample the three Scottish P4 (grade 4) research groups: Burt's Reading Test, Neale's Analysis of Reading Ability, Wechsler's Arithmetic Test, and Stott's Social Adjustment Scales. The 54 students were tested three times over the final school year, 2003–2004, and these acted as the dependent variable. The researchers gathered qualitative data over the year, and this too was considered a dependent variable. Chess instruction consisted of theory, games, and tournaments as well as after-school programming. Other than regular classroom assignments, the authors provided no description of random sampling for the study groups, which does not discount a sampling of convenience.

Analysis of pretest and posttest results for all groups showed changes in scores over the year, but the comparisons of the chess group versus the experimental control group were the most interesting. The word test showed a noteworthy improvement for the control group (computer gaming). For the teacher-led chess intervention research group, marginal gains were posted for comprehension, but it was not statistically significant. When analyzing for differences, bias was evident in the small research group sample size, affecting the accuracy of the data.

The case study finding did suggest a meaningful difference in social adjustment measures for the chess group. This study highlights the value of intergenerational chess play and how it seems to nurture and change the community's perceptions concerning school. The research seems to show that parents, grandparents, and students built new bonds of interest, and these relationships encouraged families to access new networking opportunities through community involvement. The authors believe that chess instruction — built with a community in mind — can lessen social ills and encourage self-initiated learning. Similar in relation to the work of Allen and Main (1976), the cultural effect of generating dialogue among students and their families seems to be the greatest influence that strategic gaming brings to a school-initiated program.

Kim, Park, and Baek (2009). The second study ranking as moderately relevant is Kim, Park, and Baek's (2009) "Not Just Fun, But Serious Strategies: Using Meta-Cognitive Strategies in Game-Based Learning." The purpose of the study was to determine how the independent variables of self-recording, modeling, and thinking aloud affect the dependent variables of academic achievement and gaming scores. The authors contend that the creation of educational games is an expensive and time-consuming venture; a cost-benefit analysis of developing these assistive, educational programs just does not make economic sense. The research question

focuses on whether commercial games, which engage children and are visually attractive, can be used effectively to meet educational objectives such as metacognitive strategizing. Metacognition refers, among other things, to the active monitoring of personal education or the thinking about one's own thinking (Flavell, 1976). This becomes the conceptual framework for the study. Alberta's initiative for school improvement (AISI) asks schools to actively engage everyone, but especially students, in the shared responsibility of learning (Alberta Education, 2012). It is this empirical belief that supports these researchers' question.

The study was carried out at a middle school located in Incheon, South Korea, and incorporated a large sample (N=132) of grade 9 students ranging in age from 15 to 16. Prior to beginning the study, all students were allowed to play the game and advance their skill to game level three. The researchers wanted the students to gain a certain comfort for the game, diminishing any initial frustrations.

The method was a quantitative, quasi-experimental pretest/posttest design. The pretest on academic knowledge and social problem-solving was administered first. Design features found to be important to improving learning outcomes were the three metacognitive modes (thinking aloud, self recording, and modeling). Students' learning was based on the inclusion of the computer game Gersang, which was introduced into the research schools' academic year. With similarities relating it to chess, Gersang is considered a strategic game that is based on a preindustrial Korean economy. The researchers used an achievement test prepared by the local school district to measure learning. The items on the test were related to both the grade 9 social studies curriculum and the game Gersang. The twenty-question exam weighted each question equally, and an internal consistency was established to a .921 alpha value.

Sampling for the study was drawn from the metacognitive learning responses and themes identified from the frequency with which students solved problems. The differences were particularly identifiable with the "thinking aloud" strategy, which was described as the strongest variable affecting social problem-solving ability, with modeling as the second most used variable. Social problem-solving seemed to have a positive effect on both achievement in learning and gaming. Not surprisingly, self-recording seemed to be the least effective strategy for learning and was not used often by children when engaged in gaming and play.

The strengths of this study include a large sample, pretests and posttests, and a correlation of students' responses with curriculum achievement. Since this was primarily a study of learning techniques, it was shown that any off-the-shelf strategic game, when integrated with curriculum objectives and organized with the encouragement of dedicated teachers, could be used to increase students' social and academic performance.

The initial hypothesis that academic competencies will improve with experience and understanding of metacognitive strategies is supported in the test results. However, I could argue that the students' competencies could have improved as a result of practice and experience. I agree with incorporating play in the classroom and that it mimics the reality of a child's usual approach to learning outside of the classroom. In this study, the authors demonstrated the value of modeling and discussion of favored metacognitive learning styles. With the continued evolution of Alberta's classrooms, traditional educational modes are adjusting toward a new 21st century style. Gaming seems congruous with the changes taking place.

Tully, Dunn, and Hlawaty (2006). The third study rating as moderately relevant is Tully, Dunn, and Hlawaty's (2006) "Effects of Programmed Learning Sequences on the Mathematics Test Scores of Bermudian Middle School Students." The purpose of this study design was to

compare elements of student learning styles with a student's ability to retain mathematical information. The authors sought to understand if personalized learning could affect the success of learning in middle-school students, a notion that is based on the work of Dunn and Dunn (1993). The framework outlined by the researchers linked concepts of learning styles, levels of motivation, and working in different social settings as variables that affected each student. The independent variable of a kinesthetic floor game linked to tactile resources or Programmed Learning Sequence (PLS) affected the dependent variable, students' learning, and the acquisition of fraction skills.

The convenience sample consisted of 98 sixth grade students who were from one middle school in Bermuda. The researchers randomly selected and then allocated the students to either a PLS or to a control group. Both the control group and experimental group had math classes lasting 60 minutes each day, but only the control group continued to receive traditional teaching. The design of the school day provided the research students with a constant mix of learning modes. For example, the PLS group was divided further into three sections, and each section received 20 minutes each of PLS, tactual resources, and kinesthetic games per daily session.

A pretest specifically for learning fractions, totaling seven subsets of the mathematics curriculum, was given before the intervention. A second analysis was implemented at the beginning of the study, and was based on the work of Dunn, Dunn, and Price (2000). Students' learning styles were collected, organized, and inventoried for further work within PLS groupings.

The study aimed at testing two hypotheses: (a) Does the use of innovative educational practices, including gaming, affect the acquisition of math competencies; and (b) Does learning by PLS influence the attitude and interest of learners?

In line with the first hypothesis, both the control group and experimental group were sampled before treatment to correlate for initial understandings of fractions. After studying both groups, pretest and posttest scores revealed a positive association in learning fractions after treatment. From the posttest it was further shown that the students receiving PLS programming showed considerably higher scores on their concluding fractions unit.

With respect to the second hypothesis, a comparison of scores for attitude as measured by the Systematic Differential Scale (SDS) showed that the experimental group rated PLS, tactual resources, and kinesthetic gaming with strong positive feelings more than they did traditional teaching practices. It was concluded that a competency-based education that makes allowances for students' learning styles does improve students' performance levels.

This study has several strengths, including random allocation of students to the experimental group and control group, and the use of pretests and posttests with a number of standardized measures. The sample size is adequate, even when it is divided into a control group and intervention group. The study reinforces what was learned from many of the previously reviewed studies: appealing activities like strategic gaming increase engagement.

Performance bias is present due to the creation of only a research group and control group. It could be seen as a weakness that there was only one control group and no use of a placebo. When compared to traditional teaching methods, it is difficult to know whether the research group performed better based solely on the novelty of new methods. Nevertheless, it seems that educators who understand different learning styles could develop student-focused pedagogies to successfully cultivate learning for all learners.

Kazemi, Yektayar, and Mohammandi (2011). The fourth study rating as moderately relevant is "Investigation the Impact of Chess Play on Developing Meta-Cognitive Ability and

Math Problem-Solving Power of Students at Different Levels of Education." The purpose of the study was to compare the reasoning abilities of chess playing and non–chess playing students. The authors had hoped to determine if there was any discernible effect. They had hoped to gauge a discrepancy with achievement, given a six-month period of chess participation.

The authors identified Milat (1997) and his work on children's education as the theoretical framework for guiding the study. Milat's (1997) theory is that students who play chess improve their higher order thinking, or metacognitive skills; they are also thought to heighten their ability to evaluate actions, appraise results, and predict events. Using this theory, it is asserted that there are direct links between chess and academic performance of children. Meyers (2005) believes that chess, "can directly contribute to academic performance" (Kazemi et al. 2011, p. 374).

The random sample of 180 upper elementary and junior high students was selected from Sanandaj, Iran. The demographic characteristics of the sample are not consistent with an average North American population: 100% males from grades five, eight, and nine were selected. The students had no experience with chess and were randomly broken into two groups, experimental and non-experimental. The students were expected to complete a six-month-long supplemental chess class.

The test for achievement and higher order thinking included a questionnaire of 30 metacognitive items, incorporating a Likert-like scale, a researcher-made math test of students' abilities, and The International Assessment of Math and Science knowledge (TIMSS). The curricular skills were selected from the programs of study as taught by the math instructors from the study group. Finally, the scores from the three tests were combined to create a total result for each participant.

Comparisons of the metacognitive results for the two groups show a significant difference in the mean scores. The chess-playing group score was 133, whereas the non–chess playing group score was 126. The paired t-test shows an alpha result of ($t = 5, p < .01$). The researchers found that the chess-playing activities of the students had prompted the students to develop increased metacognitive abilities. This may indicate that chess does affect student reasoning, and that the inclusion of chess might contribute to academic achievement.

Even though the study has a random sampling of participants, there is a lack of homogeneity for the sample. In Alberta's public schools, a combination of 50% male students and 50% female students would be expected. Another glaring problem is the lack of procedure explaining the merging of data. It is not certain whether the assessment tool used percentages, raw scores, or a combination of other methods to complete the final tallies. The interpretation of total scores seems biased. When considering a maximum score for the math test was six, and the total average scores were over 120, a disparity exists and needs further explanation. Finally, it would have been better if the researchers had incorporated an experimental control into their study. By including an alternative strategic gaming class, such as the one used by Forrest et al. (2005), the researchers could have tested for similar engagement as a factor of academic achievement. This is of particular interest given the conservative nature of the Iranian government. It is uncertain how dynamic, and to what extent, alternative pedagogical methods are integrated into the Iranian educational system and whether the novelty of chess education could be the cause of the reported statistical variance.

Barrett and Fish (2011). Barrett and Fish's study, "Our Move: Using Chess to Improve Math Achievement for Students Who Receive Special Education Services" (2011), is the last study to rate moderately for rigor. The purpose of this study was to compare the effects of the

independent variable, chess education, to the dependent variable, the Texas Assessment of Knowledge and Skills (TAKS). There seems to be a pattern of poor performance on standardized tests by special education students (Barkley, 2007). In regard to the Texas's Academic Excellence Indicator System (AEIS), school boards want to reduce the achievement gap between the scores of their average-student population and the scores of students receiving special education programming. Unfortunately, this statistic seems to worsen for these students as they advance in grade level.

The authors were encouraged by the work of Mastropieri, Scruggs, and Magnusen (1999), who outline a foundational approach to teaching students with learning disabilities. They suggest that activity-oriented approaches that encourage hands-on experience are preferred methods for teaching students who do not learn easily.

Scholz et al.'s (2008) study of chess instruction and learning disabled students was used as the framework for this study. Chess is believed to support concentration and basic math skills in children with learning disabilities. Barrett and Fish wanted to test the supposition that a longer duration of chess instruction may increase academic ability. The Scholz et al.'s (2008) research consisted of 51 students that were divided into two groupings and found a relationship, low road transfer, between mathematical skill and chess instruction. From assessing this and other studies, Barrett and Fish understood that more research needed to be done assessing the usefulness of longer duration, chess instruction.

A convenience sampling of students came from two middle schools in suburban Southwest United States. For both schools, the resource classes included grades 6, 7, and 8. Fifteen students from the first campus made up the experimental group. Sixteen students from the second school made up the control group. All students were diagnosed with a disability and

were able to receive special programming. The demographic makeup of the samples was approximately 65% male and 35% female.

The quantitative study used a pretest/posttest design with the sample divided into two groups. The control group participated in the regular school schedule without any supplemental activities included in their programming. The experimental group participated in the typical school schedule; however, they received 30 weeks of chess education, which was incorporated into the math curriculum. Each enrichment session happened weekly in 55-minute classes. Almost all students' learning was measured prior to the start of the study by drawing on the previous year's TAKS scores, and all students were tested during and after the enrichment sessions were completed.

The instruments used to measure students' abilities were the end-of- year course grades and math assessment scores. The six measures of math achievement were numbers and operations, patterns and reasoning, geometry and spatial reasoning, concepts and measurements, probability and statistics, and processes and tools. End-of-year course grades were based on students' Independent Educational Program (IEP) goals and objectives. Prior to the study there was no significant variance found between the TAKS scores of the two groups.

Overall, there were elements of a noteworthy difference between the groups' end-of-year course grades. The null hypothesis that there would be no change in variance was not completely supported. For the six measures found within the TAKS scores, a few select units of study did show significance, but there was not enough variance to show a correlation for the study. Nevertheless, the authors believed that the results were encouraging and that chess could still be a valuable tool, but that their results supported further exploration.

This is an interesting study in that the authors attempted to extend the duration of chess instruction for their study by following the suggestions made by previous chess researchers. Within the authors' description of a causal-comparative design, there are only marginal attempts made to produce a random sample. Each group had a different math teacher using the same state objectives, but contamination of results could occur in the variability of lessons taught. Students included in the treatment group needed to be in attendance for a minimum of 80% of the classes. It is disappointing to learn that there were no procedures requiring minimums for the control group; hence, compliance bias could have affected the results. Types of disability and socioeconomic standing were another glaring difference. The control group had a disproportionately large number of economically disadvantaged students. Due to the spectrum of learning disabilities included in the blend of special education, an actual randomization of the control groupings was inaccessible. Finally, the percentage of gender within the study was biased towards males and not a true cross section of the average student on which the TAKS is based.

Studies That Rated Low in Relevance

These are the two minor studies that examine the relationship between the playing of chess or strategic games and students' success in school. Both were rated as having a low relevance (between 1 and 3 points).

Smith and Sullivan (1997) "The Effects of Chess Instruction on Students' Level of Field Dependence/Independence" (1997) is the first study rated as having a low relevance. The intent of this research was to investigate the extent to which chess instruction affects the Field Independent (FI) capacity of the student participants. The National Science Council is concerned and recognizes that, "barriers exist today… that limit the number of women and underrepresented minorities" (p. iv) in the fields of science, engineering, and technology (2000).

The researchers hope to determine if the playing of chess will increase students' FI and begin to foster a preference for more abstract-analytical subjects, like the pure sciences.

The authors identified that Field Dependence (FD) and FI were related to human perception. This particular ability was initially found to be associated with the capacity to maintain physical orientation while piloting an airplane through a fog. The Group Embedded Figures Test (GEFT) was established to determine, with a high degree of reliability, whether individuals were predominantly: FI, FD, or a mix of the two.

The authors identified Chinien and Boutin's (1993) work as a theoretical framework guiding the study. Sullivan and Smith (1997) believe that Field Dependent individuals are more global thinkers, often need extra time to solve analytical problems, and are most numerous among women and minorities. Moreover, the researchers could not explain why socioeconomic status would be a contributing factor affecting FD individuals. Using this theory, the researchers speculated whether reinforcing FI behaviors would enable individuals to access their logical thinking abilities. Middle-school students' math scores seemed to improve by chess instruction. The researchers presupposed that chess may be the vehicle for improving students' abilities.

The purposive sample of 11 middle-school students, seven females and four males, was chosen for this study. The students had no previous experience with learning chess at school and were expected to receive 50 hours of chess instruction over two months. The students were to receive direct chess instruction from a certified teacher and an active chess player from the state of Louisiana. The chess instruction included match play that would guide the students while attending chess tournaments. There is a limited description given of the research design.

Comparisons of the test results for the group show a significant difference in scores. T-test alpha at the .05 level demonstrated to the researchers that the hypothesis was rejected for the

female participants. The same was not found for the mean scores of the male students. The researchers believe that this anomaly could be a result of male subjects' enhanced FD abilities. However, when looking at male pretest scores of one and four, it becomes apparent that half of their male study group had no ability with FD questions.

This study does not take enough precautions to account for bias. There was no randomized trial, and only a small sample of students was used. The whole study lacked control of confounding variables. Both the teacher and students were chosen purposefully. When supporting their conclusions, it is unclear why the researchers did not explain how many questions were used in the pretests and posttests. There seems to be a limited number of questions used for the test, and the results seemed to be influenced by outliers. This contributes to performance bias, which leads me to believe that the researchers were unable to produce statistically valid data. Finally, the sample was not representative of an average school population with equal numbers of male and female students.

Schneider, Gruber, Gold, and Opwis (1993) "Chess Expertise and Memory for Chess Positions in Children and Adults" (1993) is the second study with a low relevance rating for methodological and theoretical rigour. The study design involved the replication of Chi's research from 1978, which compares expert student and adult chess players with novices of similar ages. The independent variable of expert chess play was linked to the special awareness of objects on a two-dimensional game board. The dependent variable was the five trials all participants were asked to solve. The authors contend that the most impressive findings regarding memory performance are found in chess research and what the studies completed by Chase and Simon (1973) seem to exemplify; the transferability of spatial relation skill is found in the chess players' ability to recognize and reconstruct two-dimensional patterns found on a

checked board, and expert chess players have a much better ability to recall a greater number of items.

The study, which was conducted in Germany, included a convenience sample of 40 students and 40 adult participants. The demographic makeup of the adult sample was approximately 50% male and 50% female, while the child sample was 100% male. Chess ratings were used to separate the adult participants from a local university, while results from various Bavarian championships were used to determine which student participants were among the best for their age group. The samples were further divided into two groups; those considered experts and those considered novices.

This quantitative study used a comparative research design, testing each participant's ability to complete five different tasks in a span of 60 minutes. The control group participants were considered novices and had little experience with chess play. The participants in the experimental group were considered experts: members of local chess clubs and devoted tournament players. Participants in both groups consented to interviews and supplied information about their educational track, physical exercise routine, and grade average.

A repeated measure of analysis was recorded for each trial. The data show that there were substantial differences between the novice and expert chess players for typical chess board reconstruction. The difference between the groups was largest when participants attempted to reconstruct meaningful chess positions. However, repeated measurement of variance yielded data that showed experts being appreciably better on only three of the five tests given. Both the "Control Board Reconstruction Task" and the "Digit Span Task" showed no effect of age or expertise.

The researchers used a pretest and posttests design, but concerns with the whole study do appear. First, it is clearly stated that all participants in the child sample were male. By not attempting to randomize the study, generalizability with public education in the entire Western world is reduced. Even the adult population was skewed; twenty-two adult expert players were male and 18 novice players were female. It is not explained how school-generated averages for academic ability were incorporated into the study design. Other than chess ability and age, no other clear method was used to randomize the sample, thus diminishing the validity of the data presented. Problems also exist with the transferability of skills to recognized academic assessments. All tests were spatially related versions of two-dimensional game boards, not the typical skills found in programs of studies that educators use in Alberta. When looked at within the perspective of all mathematical aptitudes being taught within a whole year of study, acquiring better game board skills would be considered inconsequential. Therefore, this minimal result limits the relevance of the study.

Chapter 5 – Synthesis of the Research and Data Interpretation

In this section I will identify the major themes present in the gaming research studies and contrast them to themes present in the literature not meeting the requirements for an integrative review. The ten research papers reviewed are based mostly on quantitative research. Some attempts were made by a limited number of authors to include qualitative methods, but few followed through and completed this element of their research. Collectively the articles provided many insights into a variety of themes relating to gaming and chess. Unfortunately, the most prevalent theme existing in the articles refers to the limitations of the methodological designs used; however, other themes based on academic achievement, interpersonal skills, and curriculum development, as they relate to chess education, were considered.

Methodological Design

One theme that emerged strongly throughout the literature was the fact that gold-standard methods for increasing reliability and validity should be implemented. It is expected that scientific, medical, or psychological research begin with reliable measures. Recognized practices should be used in educational research to establish, in the case of chess, whether instruction does affect some developmental objective such as intellectual ability, attitude toward learning, or simply better school grades. The randomization of controls means that treatment groups are about the same before intervention. Barrett and Fish (2011); Kazemi, Yektayar, and Mohammandi (2011); and Schneider, Gruber, Gold, and Opwis (1993) relied on a majority of male participants from public schools for their control groups. Both Schneider et al. (1993) and Kazemi et al. (2011) used males exclusively. This lack of control of variables, although interesting, is a glaring example of results that cannot be easily transferred to a typical public school population.

At the very least, it is thought that a quantitative researcher should allow for a group receiving chess instruction to be compared to a control group. It is understood that a better design of a quantitative research study would allow for an experimental effect, thus including one control group with an alternate treatment and one group getting none at all. Only the Forrest et al's 2005 study was able to achieve this highest level of diligence; therefore, the term strategic gaming was used to describe a variety of chess-like games that could be included and reviewed in this research paper and used to account for any missing alternative treatment or experimental control from the chess research. In this regard, Tully, Dunn, and Hlawaty (2006) and Kim, Park, and Baek (2009) showed an increase in students' academic achievement based on the inclusion of a strategic game in their research. Again, these were studies with treatments closely related to chess.

Another assurance found in outstanding research is the masking of the goal of the experiment to the participants and the experimenters. Given the diligence with which Western governments guard their citizens' rights, it is unimaginable to think that contemporary researchers would conceal their investigations from parents and their children. This new demand on conserving entitlements makes it challenging to organize a model study. The most recent gaming studies, such as Barrett and Fish (2011); Kim, Park, and Baek (2009); and Hong and Bart (2007), garnered parental, school district, and/or university approval prior to beginning their research. The relevance of their findings must be held to more rigorous scrutiny because the increase in bias does have a greater chance of skewing their results.

Other examples of better measures include having different people acting as researchers for the study and using them to carry out the treatment, both pretest and posttest. The chance of contaminating the collected data is further reduced if these steps are taken. Hong and Bart

(2007); Ferreira and Palhares (2008); Forrest et al. (2005); and other better studies included strict controls for the randomization of control groups and testing, earning them higher relevance within this research project.

Finally, the major limitation of these research studies is small sample size. In some instances there were 180 participants, but when divided by too many subgroupings, doubts emerge as to whether there are sufficient numbers to produce reliability in these quantitative studies. For example, studies like Barrett and Fish (2011); Smith and Sullivan (1997); Schneider et al. (1993); and Forrest et al. (2005) have subsets of participants fewer than 20 and as few as 11. As sample groupings decrease in size so does the lack of power. The power of a study is influenced by the magnitude of the true difference, the standard deviation of the population means, and the sample size. None of these researchers calculated the power needed to show statistical significance. For these researchers it was unknown what sample sizes would have been adequate to achieve their research goals.

Given this evidence, the ideal research study was not uncovered. Therefore, studies could be categorized as diluted versions of the best research studies or as "quasi-experimental."

Academic Achievement Factors

All but two of the studies examined in this paper investigated a relationship between strategic gaming and academic achievement. The findings in Smith and Sullivan's (1997) study supported the hypothesis that Field Independence would be improved in the experimental group when the students were exposed to chess education. However, there is debate as to whether the skill set attained by playing chess is the basis of intelligence. An example of little or no transfer of ability can be found in the Schneider et al. (1993) research, which reported that children who play chess outclass adults who do not play chess in the recall of viewed chess pieces. But the

same adults were much better at remembering lists of digits than were the chess-playing children. I agree with Schneider et al. (1993) that increasing one's ability in an area like Field Independence does not guarantee a residual effect influencing future math and science aptitudes. The leap of faith used by the researchers to bolster their hypothesis is not enough to make the assumption plausible. Ferreira and Palhares (2008), while using a much larger sample, were unable to prove any associations in their tested hypothesis, and instead found only a weak significance with pattern recognition. No other linkages could be made, regardless of the intervention. This is a noteworthy finding considering that Ferreira and Palhares's treatment group had more than nine times the number of research participants than did Smith and Sullivan's.

In contrast to Smith and Sullivan's (1997) study, Allen and Main's (1976) research into absenteeism shows a more interesting connection between chess education and transferability. Without student attendance, it is understood that learning and its assessment cannot take place. The result of this study was that for the first time in recent history the inner-city students were attending school more consistently and were consequently doing better. A meaningful effect was produced. Students did attend school much more frequently, but only as long as they were allowed access to chess classes. The novelty of chess instruction as compared to study hall showed the important difference. Regrettably, once the optional chess class was withdrawn, students returned to their typical patterns of behavior. Post testing showed that students did not attend regularly and denied themselves an opportunity to learn new information and be assessed for learning it. Neither transferability nor residual effect was produced via chess education.

Interpersonal Skills

Morrow states,

> Many of the studies which measure social capital seem to assume that individual children are only influenced by family structure and school. They do not give account of the broader social context, such as friends, social networks, out of school activities, such as paid work and children's activities in their communities. (Morrow, 1999)

The Alberta Learning Information Service (ALIS) contends that employability skills can be varied and quite specific, but all employers desire personnel that have skills in teamwork, communication, and personal management. All of these abilities fall under the category of interpersonal skills, and Alberta Education provides programming and curricula to develop both of these throughout a child's school-age years. There is an emphasis on gaining interpersonal skills during the grade school years because these aptitudes are the most challenging for employers to alter in adults.

Forrest et al. (2005) found that the informal coaching relationship and structured chess education that they implemented into the Aberdeen primary schools assisted some students who had displayed social and emotional difficulties prior to the introduction of the research study. Chess play allowed the students to take an active role in their learning and to demonstrate to family and community members their newfound abilities. In their initial analysis of data, Forrest et al. (2005) found there was a substantial improvement in the treatment group over the control group, particularly given the similar pretest baseline for social adjustment. The same could be said for students' perceptions of playing the strategic game Gersang (Kim et al., 2009). The game Gersang was well-integrated into the social studies curriculum, and they realized important

gains in the students' academic achievement and problem-solving skills. The students' perceptions of best learning linked highest with "thinking aloud" and "postgame strategizing." The more traditional learning technique of "self-recording" was least valued by students when assessing their acquisition of strategy and game play. It seems that experiential learning that allows students to see the consequences of their actions gives students an opportunity to share with others, prompts students to remain engaged, and encourages superior learning.

Curriculum Development

Seven studies — Barrett and Fish (2011); Ferreira and Palhares (2008); Forrest et al. (2005); Kazemi et al. (2011); Kim et al. (2009); Smith and Sullivan (1997); and Tully et al. (2006) — integrated chess or strategic gaming into school programming. Alberta Education, in its document *Making a Difference* (2010, p. 64), describes differentiated learning experiences as, "ensuring that students are engaged in a variety of meaningful activities and contexts." The term *variety* is further discussed, and educators are reminded that the goal is not to have an assortment of learning modalities for the sake of variety, but to have students demonstrate program of studies outcomes, those skills that are considered learning objectives, while being engaged in stimulating activities. It is proposed that gaming can be used as an innovative way to involve learners, but not necessarily as an end in itself.

As mentioned earlier, the practical limitations of testing for the academic improvement of students based solely on a game are fraught with many obstructions. Whether attempting to organize research that prevents bias due to demand characteristics, meeting modern ethics standards without revealing measures, or controlling the experimenter/teacher expectancy effect, the sampled educational research has had a difficult time meeting the standards commonly used in scientific research.

The finding in Kim et al. (2009) supports the hypothesis that gaming can improve academic results and increase a student's engagement in learning. The game Gersang was described as a chess-like game but steeped in Korean economic history, a perfect match for the social studies curriculum, which parallels their state and educational objectives. I agree that the students did much better academically, but the test scores could also be a combination of classroom novelty and teacher/experimenter effect. As found in the Forrest et al. (2005) study, students who were in the control group and allowed to play chess on computers were as successful, academically, as those who were in a segregated PC classroom setting. Forrest et al. (2005) were unable to prove their hypothesis and found student literacy and numeracy developments did not differ significantly between the control and the experimental groupings. Regardless, qualitative measures did show that the teacher facilitators did succeed in altering children who had previously exhibited social and emotional difficulties. Forrest et al. (2005) noticed that students rated the educational practice, after-school gaming programming, and tournaments highly. This finding, I feel, validates the power of incorporating differentiated instruction, and gaming, into the curriculum.

In her work *"Insights from Neuroscience and Developmental Science to Help Every Child Succeed"* (Frank, 2013), Dr. Adele Diamond from the University of British Columbia reasons that everyday activities such as sports, dance, music, and storytelling are fundamental to children's emotional success. By encouraging student involvement rather than accepting tacit observation, many objectives such as problem solving, goal setting, concern for others, and tolerance seem to be enhanced. The work of Forrest et al. (2005) shows not only a linkage between a student's emotional balance and engaged teacher experimenters but to Dr. Diamond's work. Students' emotional balance was improved; gaming permitted children a period of

undivided attention with their peers and parents, and increased civil interactions with their siblings, allowing for positive changes in attitude.

Tully et al. (2006) identified the use of a Programmed Learning Sequence (PLS) as influencing the academic achievement of their experimental group subjects. Gaming and knowledge of learning styles was thought to be an essential part of daily instructional lesson planning. Knowing and discovering the learning styles of students increases their engagement, and in the case of Allen and Main's (1976) work, it dramatically increased students' attendance. As an alternative to traditional teaching practices, using Personal Learning Strategies showed a marked improvement in both students' achievement and attitude scores. A sample of $n = 98$ in this pilot study supports a weighty finding based on their results. Unfortunately, the variety of interventions used over the course of the fractions unit was vague. All participants were rotated through three 20-minute lesson sessions, including a tactual and kinesthetic floor game. The intervention group not only scored significantly higher than the control group on both the pretests and posttests but 92% of the students responded to their experience with the PLS as either a strong or positive one. I agree with the authors' belief that using a differentiated approach may increase students' appreciation of schooling.

Chapter 6 – Conclusions and Recommendations

Those who encourage the use of chess for its ability to enhance students' academic and interpersonal skill sets seem to be fortified by chess masters' elucidations and chess associations' boasting. Much of the support found in mainstream media references chess experts' personal opinions and seems to be reported with little regard for studies that respect academically endorsed methods. It would be advised that future chess researchers meet the requirements of peer-reviewed journals and get published in respected educational publications prior to releasing their findings.

Guiding Teacher Pedagogies

The BC Chess Federation (2013) presently reports the benefits of chess as shaping a student's science achievement, English skills, intellectual maturity, creativity and memory enhancement, to name a few. Moreover, they describe the variety of students that can be enriched by a chess education as spanning the spectrum, from the gifted to those struggling academically. Why would parents not organize their children's schedules to include some chess education?

In my view, chess does not appear to affect a student's academic skill set. As seen in the work of Hong and Bart (2007); Ferreira and Palhares (2008); and Forrest et al. (2005), when a study uses proper random sampling of students, no substantial data can be found to support scholastic gains. Future research should do its best to follow the most ideal research methods.

Still, not everyone is interested in playing this individual game. Hong and Bart (2007) showed that after a period of treatment, some students excelled at the game while others continued to play chess poorly. It is just not for everyone. Perhaps a relationship could be revealed in Field Independent (FI) individuals or those captivated by strategic games. As

Schneider (1993) notes, there are differences between the subsets of society such as talkative extroverts and quiet introverts. Perhaps there are certain types of individuals who naturally invest many more hours in the understanding of best chess strategies and enjoy intense gamesmanship. When looking at the analysis of data (Smith & Sullivan, 1997), Field Dependence (FD) is highest among women. Not surprisingly, many studies in this paper were biased towards males (Barrett & Fish, 2011; Kazemi, Yektayar, & Mohammandi, 2011; Schneider, Gruber, Gold, & Opwis, 1993). Participation rates of male and female chess players around the world are skewed as well. It is characteristically described as a ratio of 16:1 in favor of the male population (Oxford Chess Research, 2013). Perhaps researchers could be more restrained when establishing outcomes grounded in such biased data.

Kim, Park, and Baek (2009) and Tully, Dunn, and Hlawaty (2006) highlight the inclusion of differentiated education, and demonstrate how strategic games can be used to encourage learning for all students. Inclusive education is certainly a recommended condition for the presence of chess or any variety of strategic gaming in Alberta classrooms. When coupled with curriculum objectives, games can engage students and add newness. This may explain why "thinking aloud strategies" and the student "modeling" of game scenarios seem to garner the majority of positive student responses in Kim, Park, and Baek's (2009) qualitative research. As suggested by Alberta Education (2010), students are to be engaged in an assortment of meaningful activities that meet their diverse learning needs. Gersang, a strategic game, seems to be an innovative and engaging strategic game that meets the objective of garnering learner attentiveness.

Recommendations for Further Research

But how will educational research continue to improve? Researchers could begin by attempting to incorporate an experimental control into all new research studies. The Forrest et al. (2005) research set a standard that others should realize. Given the number and layers of bias uncovered during my analysis of chess and strategic gaming research, it is difficult to imagine that future studies will be able to better control for unintentional prejudice and demand characteristics. Strict modern codes of ethics found in Canada and the Western world only compound systematic error. Research subjects that recognize and realize their condition of being studied act differently.

A lack of participants in studies is another typical problem that I found in my review of chess research. Small representative samples increase the possibility of erroneous conclusions and Type I errors. It is these treatment effects that I believe have been exaggerated by low participation rates. When attempting to model better educational research methods it seems likely that classic quantitative research techniques may need to be set aside for newer stratagems.

Data mining, analysis of correlations, and other statistical means of study may hold the answer to better chess research (Holsheimer & Siebes, 1994). The problems of interfering with participants and manipulation by the experimenters and teachers can be greatly reduced if these alternate methods are used. Approaches like data mining, where researchers are not as openly in contact with participants, can engage a larger number of research subjects more easily. Standardized testing has been used for decades in Alberta, and these stores of information could be exploited to draw correlations with chess participants. Moreover, ethical processes for data mining should not affect random samples to the extent that traditional methods have.

The use of chess in schools is random and not a consistent practice in educational jurisdictions. There is little evidence to prove that it develops higher levels of critical thinking or academic excellence. Nevertheless, chess is a game that has been around for ages, and it does allow students an opportunity to work together with peers, create supportive relationships, and encourage those who would like to be engaged in tournament play, but there is an expectation in education that students meet educational objectives. Unfortunately, chess play has been shown to have few transferable skills that meet Alberta Programs of Study (Alberta Education, 2013).

Even though there is a pressure for schools to be innovative and make purposeful change, it is critical that a theoretical framework be evaluated through peer review guides prior to the implementation of chess into school settings. Until this occurs it is important that chess be applied to education like any other extracurricular activity.

Chess is well-received by many students due to its unobtrusive, disciplined play. Students report that chess provides them with challenging gameplay with their peers and community members. Chess players do develop social skills that they can improve. Given teacher expectation, coaching relationships, tournament play with new acquaintances, and peer networking within clubs, it is important that educators understand the social capital gained through chess play, and that it can be used to cultivate the self-esteem of interested learners.

Conclusions

Finally, better research is needed to document the effectiveness of using chess to enhance the academic achievement of students. The presented research studies all advocate further study of chess to discover if there are any linkages with student academic success. Improving education by integrating quality-differentiated instruction seems to be a modern teaching practice that has taken hold in Alberta. Perhaps there is a place for chess. Still, not only

are well-integrated strategic games and simulations appropriate and wanted in the classroom, but so too are role-play, project design, brainstorming, and classroom presentations (Franzoni & Assar, 2009; Tully, Dunn & Hlawaty, 2006). It should take much more promising research to engage educators in the process of including chess into their typical classroom practice.

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Yeh, S. (2011). The cost-effectiveness of 22 approaches for raising students' achievement, *Information Age Printing.*

Appendices

Appendix A .

Table 1

Included Articles

CITATION	PURPOSE	INCLUSION CRITERIA
A len, L., & Main D. (1976). The e ect of instructional gaming on absenteeism: The first step. *Journal for Research in Mathematics Education, 7*(2), 113–12.	How will the inclusion of chess class affect the attendance of Detroit inner-city students? Design three scenarios to test for wanted behavior.	N=80; meets inclusion criteria; multisite study; good description of research instrument, methodology, and limitations of the study.
Barrett, D., & Fish, W. (2011). Our move: Using chess to improve math achievement for students who receive special education services. *International Journal of Special Education, 26*(3)	To use more than 6 months of school programming to evaluate chess's effectiveness altering the achievement of middle school students in special education programming.	Not a rigorous research study; does not fully describe sample size, methodology, etc.
Ferreira, D., & Palhares, P. (2008). Chess and problem solving involving patterns. *The Montana Mathematics Enthusiast, 5*(2), 249–256.	What is the impact of chess education on pattern recognition and problem solving? Based on the previous research of Krutetski (1976).	Quantitative with co-relational design; independent reviewers, including analysis of variance, pre and posttest. N=105 elementary students.
Forrest, D., Davidson, D., Shucksmith, J., & Glendinning, T. (2005). *Chess development in Aberdeen's primary schools: A study of literacy and social capital.* Scottish Executive Education Department Sponsored Research Project.	How do the teaching faculty and students perceive the integration of chess programming into the school? Is there a relationship between chess and academic achievement?	N=54; theoretical framework described; mixed-design methodology; good description of research; meets inclusion criteria.
Hong, S., & Bart. W. (2007). Cognitive effects of chess instruction on students at risk for academic failure, *International Journal of Special Education*, *22*(3), 89–96.	Does the inclusion of 90 minutes of chess education once a week for three months increase achievement levels of elementary grade students?	Quasi-experimental, ethnographic study. N=38 students randomly assigned; good description of research instrument; Korean Basic Skills Test (KBST), Raven's Progressive Matrices Test (RPM), Standard Progressive Matrices (SPM) and Test for Nonverbal Intelligence (TONI-3).

CITATION	PURPOSE	INCLUSION CRITERIA
Kazemi, F., Yektayar, M., & Mohammandi, A. (2011). Investigation of the impact of chess play on developing meta-cognitive ability and math problem-solving power of students at different levels of education. *Procedia – Social and Behavioral Sciences*, (32), 372–379.	Assess for an increase in problem-solving ability of students who play chess.	Experimental design including analysis of variance, assessment of student learning styles using a 5-point Likert scale, and pre and post tests. Students are randomly selected.
Kim, B., Park, H., & Baek, Y. (2009). Not just fun, but serious strategies: Using meta-cognitive strategies in game-based learning. *Computers & Education*, *52*, 800–810.	Comparing the effect of students' learning in Korea with the strategic game Gersang.	Matches inclusion criteria with 132 participants from 15 to 16 years of age. Ethical approval; report of demographic information for the sample and description of research instrument.
Schneider, W., Gruber, H., Gold, A., & Opwis, K. (1993). Chess expertise and memory for chess positions in children and adults. . *Journal of Experimental Child Psychology*, 56, 328–349.	To test if there are a significant difference between expert and novice chess players, based on 5 different tasks.	Quantitative research, N=20. Random sampling completed by chess club. An extension of Chi's (1978) study.
Smith, J., & Sullivan, M. (1997). *The effects of chess instruction on students level of field dependence/independence*. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, Memphis, TN.	What is the relationship between students' spatial relations skills (FI) and academic success?	Quantitative research, N=11. Sample of convenience. Pre and post assessments using Group Embedded Figures Test. Sixty days of treatment by expert chess player and certified teacher.
Tully, D., Dunn, R., & Hlawaty, H. (2006). Effects of programmed learning sequences on the mathematics test scores of Bermudian middle school students, RMLE. 30(2), 1-11	What is the effect of PLS programming on the academic achievement of sixth grade students?	Quantitative study with pre and post tests. Sample size N=98; good description of research instrument, methodology and limitations.

Appendix B

Table 2

Excluded Articles

CITATION	PURPOSE	EXCLUSION CRITERIA
Bart, W., & Atherton, M. (2003, April). *The neuroscientfic basis of chess playing: Implications for the development of talent and education.* Paper presented at the annual meeting of the American Educational Research Association. Chicago, IL.	Theory describing amateur and expert chess players' memory. MRI blood flow illustrations of brain function.	Research report only; assumptions based on imaging are used to explain cognitive abilities.
Celone, J. (2001). *The effects of a chess program on abstract reasoning and problem-solving in elementary school children,* Ann Arbor, MI: Bell & Howell Information and Learning Co.	Review of research material associated with academic achievement and children.	Discussion paper.
Charness, N., Reingold, E. M., Pomplun, M., & Stampe, D. M. (2001). The perceptual aspect of skilled performance in chess: Evidence from eye movements. *Memory & Cognition*, 29, 1146–1152	Quantitative study of expert and amateur chess players' ability to distinguish between threats on a game board.	Research with adult subjects.
Chi, M. (1978). Knowledge structure and memory development. In R. S. Siegler (Ed.), *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.	Quantitative study comparing expert student chess players to non-expert adults through various memory tasks.	N=6 child experts. Adult participants included.
Dauvergne, P. (2000). *The case for chess as a tool to develop our children's minds.* Lecture for the University of Sydney. Retrieved from www.gardinerchess.com	Memory and IQ testing for verbal and numerical aptitude of students.	Journal article reviewing a research study. No method described. N=14.
Ferguson, R. (1994). Teaching the fourth "R" (reasoning) through chess. Retrieved from http://www.gardinerchess.com/publications/fourth-r.pdf	Test chess students using Watson-Glaser Critical Thinking Appraisal and Torrance Test of Creative Thinking. Non-randomized, students' choice.	Not a rigorous research study; does not meet peer review criteria.

CITATION	PURPOSE	EXCLUSION CRITERIA
Fischer, W. (2006). The educational value of chess, new horizons for learning. Retrieved from http://www.newhorizons.org/strategies/	Effects of including First Move curriculum into second and third grade ESL classrooms.	Systematic qualitative review.
Holding, D. (1992) Theories of chess skill, *Psychological Research*, *54*, 10–16	To review research on chess players' memory and recent computer game simulators.	Describes recognition-association theory.
Liptrap, J. (1999). Chess and standardized test scores. *Chess Life*, (03), 41–43.	Test for self-esteem, confidence, and educational achievement based on chess club participation.	Not a rigorous research study; does not meet peer review criteria.
Margulies, S. (1992). The effect of chess on reading scores: District nine chess program second year report. *The American Chess Foundation*, New York.	To determine if chess education will have an effect on elementary school students' reading skills and/or enhance intellectual interests.	Not a rigorous research study; does not meet peer review criteria.
Moldow, E. (2007). After-school program activities and academic achievement: A study in one urban K-8 school. Retrieved from: http://books.google.ca/books?id=lToD1SJthZ4C&printsec=frontcover#v=onepage&q&f=false	Non-randomized study of student achievement. After-school participant activities include: architecture, chess, computers, crochet, dance, French, math club, music, and swimming. Attenders compared to non-attenders report card grades.	All after-school events are combined for data processing. Chess measurement not singled out and revealed.
Rilner, P., & Feldjusen, J. (1997). Checkmate: Capturing gifted students' logical thinking using chess. *Gifted Child Today Magazine, 20*(1), 36–42	Will alternate approaches to teaching chess to children work better than past methods? Tests were coded for problem-solving ability.	Discussion paper. N=10.
Unterrainer, J., Kaller, C., Halsband, U., & Rahm, B. (2006). Planning abilities and chess: A comparison of chess and non-chess players on the Tower of London task. *British Journal of Psychology*, *08*(97), 299–311.	To compare chess and non-chess players' abilities to solve strategic game scenarios based on time and ability. Testing for differences in intelligence using TOL and Raven Tests.	Young adults (post-secondary students) chosen.