

**Teaching with Chess: Exploring the Relationship between Chess and Student Learning Outcomes**

ACIS Years 1-3 Report<sup>1</sup>

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## About the Study

This report describes Years 1, 2, and 3 of a five-year study that examined the use of chess in instruction in elementary and middle grades. Part of the evaluation involved examining the relationship between the use of chess during core subject area instruction and critical thinking skills (as well as other 21<sup>st</sup> Century Skills). The study employs a longitudinal quasi-experimental control group design, where the control group consisted of students who were not exposed to chess or any particular alternative teaching strategy.

In consultation with Jerry Nash, a private chess education consultant, participating teachers developed the curriculum to incorporate chess in instruction to best meet the students' academic needs. The outcomes that were assessed and are addressed in this report are (i) critical thinking as measured by the Cornell Critical Thinking Test and (ii) students' proficiency with 21<sup>st</sup> Century Skills as assessed by their teachers. In Year 3, teachers and students participated in surveys that measured their perceptions of the influence of chess instruction.

## ACIS Program Description

The Alabama Chess in Schools methodology focused on training teachers to use chess in the classroom as a means to teach curriculum standards, critical thinking, and 21<sup>st</sup> Century Skills. Participating schools received grant support based on a selection process that evaluated administrative and staff buy-in at the elementary, middle, and high school levels with schools in the same feeder pattern. Preference was given to those school systems with no history of a chess program. Since state funding targeted the at-risk student population, the schools selected had relatively high at-risk [Title 1] demographics. As a condition of receiving free training and support, participating school systems agreed to formally assign, in addition to chess teachers, a "chess lead" for the school district and for each school to provide local oversight and coordination. This three-tier approach proved critical in minimizing the risk of program failure due to personnel turnover. Each school district signed a memorandum of understanding outlining responsibilities of the schools and the ACIS service provider. School responsibilities included participation in research, reporting of key milestones, and an issue management process.

Administrators attended an orientation each March so they could understand the initiative timeline and expectations. Teachers new to the program attended a four-day professional development in the summer. The majority of teachers had little-to-no chess training. As a prerequisite to the four-day class, teachers were given ChessKid<sup>2</sup> accounts and asked to complete the Pawn level series of lessons to learn how each chess piece moves. The training introduced teachers to the game of chess while emphasizing curriculum connections in literacy, math, critical thinking, and life skills. In addition, teachers created lesson plans using chess to teach a curriculum topic and learned how to use the technology provided by ChessKid, an online playing and tutoring site. After the first summer, returning teachers participated in a two-day training that focused on chess skill development and lesson planning.

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<sup>2</sup> More information about ChessKid is given in Sections III and IV of the report. The link to ChessKid is: <https://www.chesskid.com/what-is-chesskid>

Returning teachers also shared lessons learned with first year teachers during joint sessions. Teachers were given flexibility as to how they would implement chess in their classrooms but were required to include chess or chess-based lessons at least 1-2 hours per week during the day and to start after-school clubs. ACIS support included an online Resource Library of teacher-created lesson plans, on site visits, and ChessKid memberships for teachers and students.

Metastudies in chess in education research generally suggest that learning and playing chess increase executive and critical thinking skills simply by virtue of playing the game. While this may be true, Chess in Schools' methodology seeks to transfer these skills from the abstract to the concrete domain in a more direct manner through specific language and thinking skills derived from chess thinking. By using a purposeful approach to the transference of these skills, the researchers hope to make a more rapid transition in thinking that enables students to evoke the skills at will. Chess in Schools crafts lessons that utilize the vocabulary and thinking skills from the discipline of chess as a process with which to approach more generalized academic and life situations. These processes are then tied directly to standards and academic skills in the areas of reading, math, social sciences, and science and to life situations.

When introducing academic lessons, teachers and students together specifically define, analyze, and practice the necessary defined thinking skills related to chess that will be needed to solve a problem or achieve a goal in various academic and life situations. This methodology requires that teachers use specific language to evoke "chess thinking" as they introduce lessons tied to academic standards and pragmatic tasks, calling attention to how chess players would think and go about solving them. With practice, simply reminding students that they will be "thinking like a chess player" the researchers hope to broaden the disciplined thinking required in chess to specific academic areas.

In addition, standards based academic lessons are directly tied to chess, using chess vocabulary, metaphors, comparisons, or even chess equipment as manipulatives in order to further establish the connections between chess thinking and academic or life situations. For example, a chess board could be compared to map coordinates or used as a grid to teach multiplication or fractions. Tactical chess puzzles can be used as models to assess problems, consider consequences, and make informed decisions. During training sessions, teachers are asked to reflect on what they will be teaching in their individual classrooms and to prepare lesson plans that connect chess with their particular grade level and subject standards.

Critical dimensions of successful program adoption are the group training, teacher-student collaboration, and a foundation of teacher, school, and system buy-in, without which the strength of the intervention is likely to rapidly fade. Enthusiastic and committed consultants and trainers, who are also capable of promoting program concepts and benefits to administrators, teachers, and funding sources, are also critical to a successful launch of chess in schools.

### **Report Structure**

This report includes results from the first three years of implementation (2015-16, 2016-17, and 2017-18). The report is divided into sections as follows:

1. The first section of the report addresses the evaluation of critical thinking from the years 2015-16 and 2016-17.

2. The second section presents findings from the 21<sup>st</sup> Century Skills evaluation for all three years.
3. The third section presents findings from a survey of teachers of chess from Spring 2018.
4. The fourth and final section includes findings from a survey of students of chess from Spring 2018.

## Section I

### Evaluation of Critical Thinking (The Cornell Critical Thinking Test)

Students' critical thinking skill development was assessed by the Cornell Critical Thinking Test. Students were administered a pretest at the beginning of the academic year and a posttest at the end of the academic year. Data were analyzed for students in grades 4-11. The analysis compared two groups of students—exposed to chess (intervention) and not exposed to chess (control)—at each grade level, controlling for their pretest performance. Findings from Year 1 and Year 2 (2015-16 and 2016-17) are juxtaposed in the tables.

Table 1 shows the distribution of students by intervention and control groups for each grade level. There were generally more students in the intervention group than the control group at each grade level. During Year 1, comparisons could only be made for students in grades 4 through 8. During Year 2, data were also available for grades 9 through 11. For each intervention classroom, effort was made to identify a control classroom to facilitate comparison. However, sufficient data were not available for control groups in Year 3 and so the analysis for critical thinking was not conducted. The available data for Year 3 were unreliable to derive meaningful conclusions.

Table 1: Distribution of Students by Grade and Group

Grade	Year 1		Year 2	
	Control	Intervention	Control	Intervention
4	42 (35.6%)	100 (38.8%)	60 (20.9%)	70 (13.7%)
5	21 (17.8%)	45 (17.4%)	51 (17.8%)	183 (35.9%)
6	21 (17.8%)	43 (16.7%)	85 (29.6%)	83 (16.3%)
7	20 (16.9%)	19 (7.4%)	23 (8.0%)	61 (12.0%)
8	14 (11.9%)	51 (19.8%)	23 (8.0%)	72 (14.1%)
9	-	-	27 (9.4%)	21 (4.1%)
10	-	-	15 (5.2%)	20 (3.9%)
11	-	-	3 (1.0%)	0 (0%)
<b>Total</b>	118 (100%)	258 (100%)	287 (100%)	510 (100%)

The Cornell Critical Thinking Test measures five constructs: induction, observation, credibility, deduction, and assumptions. The definitions of each of these constructs are described in subsequent sections when the results are reported for the intervention and control groups. In presenting the findings, the constructs of observation and credibility are combined because they were measured by overlapping items on the test. The analysis for this evaluation involved comparing group means while adjusting for pretest performance. The subsequent tables display adjusted means for each section, and patterns of differences between the means are examined.

Tables 2-5 show the descriptive statistics for the intervention and control groups at each grade level for overall post-test scores as well as the five constructs measured by the Cornell Critical Thinking Test.

## Induction

Induction (inductive reasoning) is the process through which students move from recognizing meaningful patterns in specific observations to the creation of a hypothesis, theory, or generalization. As shown in Table 2, for this construct:

- The intervention group scored higher than the control group in grades 4, 5, 6, and 8 in Year 1. In Year 2, the intervention group scored higher than the control group for grades 4, 8, and 9.
- The intervention group score means were slightly lower than the control group for grade 7 in Year 1; and grades 5, 6, and 7 in Year 2.

Table 2: Induction Score Summary Statistics by Grade and Group

Grade	Group	Year 1		Year 2	
		Mean	Std. Error	Mean	Std. Error
4	Control	12.71	.57	10.42	.60
	Intervention	13.40	.37	12.53	.46
5	Control	13.92	.80	13.44	.74
	Intervention	14.03	.54	12.92	.20
6	Control	13.02	.83	11.44	.95
	Intervention	15.64	.58	10.99	.49
7	Control	16.24	.87	11.58	.84
	Intervention	13.07	.90	10.64	.79
8	Control	13.27	.90	12.47	.71
	Intervention	13.28	.47	13.13	.68
9	Control	-	-	13.10	.65
	Intervention	-	-	14.37	.78
10	Control	-	-	14.54	.88
	Intervention	-	-	12.81	.64

### Observation and Credibility

Observation is the ability to recognize facts and meaningful patterns. Credibility refers to the accuracy of the observations. Observation and credibility judgments call for the application of principles, which is a deductive process, and thus may also be construed as part of deduction. As shown in Table 3, for this construct:

- The intervention group score means were higher than the control group for grades 4, 5, and 6 for Year 1; and grades 4, 5, 6, 8, 9, and 10 for Year 2.
- The intervention group score means were lower than the control group for grades 7 and 8 in Year 1; and grade 7 in Year 2.

Table 3: Observation and Credibility Score Summary Statistics by Grade and Group

Grade	Group	Year 1		Year 2	
		Mean	Std. Error	Mean	Std. Error
4	Control	9.29	.49	9.42	.44
	Intervention	10.14	.31	9.56	.36
5	Control	10.31	1.66	10.06	.63
	Intervention	11.05	.35	10.36	.24
6	Control	8.64	.68	9.37	1.06
	Intervention	10.78	.47	9.73	.54
7	Control	11.02	.67	9.32	.64
	Intervention	9.72	.69	8.98	.61
8	Control	10.83	.90	9.53	.61
	Intervention	10.40	.47	10.12	.58
9	Control	-	-	10.13	.50
	Intervention	-	-	12.17	.60
10	Control	-	-	10.08	.98
	Intervention	-	-	10.90	.71



## Deduction

Deduction (deductive reasoning) is the process through which a student demonstrates understanding of a theory, concept, or generalization through application to a specific situation. The summary statistics are presented in Table 4. For this construct:

- The intervention group score means were higher than the control group for grades 4, 5, and 6 in Year 1; and grades 4, 5, 6, 8, and 10 in Year 2.
- The intervention group score means were lower than the control group for grades 7 and 8 in Year 1; and grades 7 and 9 for Year 2.

Table 4: Deduction Score Summary Statistics by Grade and Group

Grade	Group	Year 1		Year 2	
		Mean	Std. Error	Mean	Std. Error
4	Control	8.86	.52	6.09	.47
	Intervention	10.77	.33	7.73	.39
5	Control	11.64	2.19	8.69	.62
	Intervention	12.52	.46	7.71	.24
6	Control	10.39	.75	4.99	.77
	Intervention	11.29	.51	6.20	.40
7	Control	10.41	.62	6.62	.48
	Intervention	9.89	.64	5.58	.47
8	Control	11.68	.90	6.57	.59
	Intervention	10.59	.48	7.56	.58
9	Control	-	-	8.36	.86
	Intervention	-	-	8.08	.98
10	Control	-	-	8.78	1.92
	Intervention	-	-	9.25	.84

## Assumptions

The Assumptions construct refers to a supposition made by the student in order to complete a task or make an evaluation. Descriptive statistics for this construct are presented in Table 5.

- The intervention group score means were higher than the control group for grades 4, 5, 6, and 8 in Year 1; and grades 4, 6, 7, 8, and 10 in Year 2.
- The intervention group score means were lower than the control group for grade 7 in Year 1. There seemed to be no difference in Year 2 for grade 5.

Table 5: Assumptions Score Summary Statistics by Grade and Group

Grade	Group	Year 1		Year 2	
		Mean	Std. Error	Mean	Std. Error
4	Control	3.32	.39	2.94	.28
	Intervention	3.52	.19	3.38	.24
5	Control	3.31	1.13	3.73	.39
	Intervention	3.58	.24	3.67	.14
6	Control	3.24	.43	3.40	.54
	Intervention	3.89	.29	3.67	.28
7	Control	4.33	.39	2.51	.39
	Intervention	3.45	.39	4.11	.37
8	Control	3.03	.48	3.42	.36
	Intervention	3.34	.25	3.68	.34
9	Control	-	-	4.39	.64
	Intervention	-	-	3.91	.83
10	Control	-	-	2.95	1.33
	Intervention	-	-	5.87	.50

## Overall Posttest Score

Overall posttest scores in the intervention group were higher for grades 4, 5, and 6 in Year 1; and for grades 4, 6, 8, and 10 in Year 2. This implies that students in those grades who were exposed to chess tended to demonstrate improved critical thinking skills over their peers who were not exposed to chess. The intervention group scored lower than the control for grade 7 in Year 1. This trend was consistent across all five constructs. In Year 2, the overall posttest adjusted means for the control group were higher than the intervention group for grades 8 and 9.

## Summary of Findings Related to Students' Critical Thinking Skill Development

For the Induction and Deduction constructs, students exposed to the chess intervention had noticeably higher scores than the control group students, in the lower grade levels in particular (4-6). Chess instruction did not appear to have much of an impact on induction or deduction

skills for students in grades 7 and 8. These data imply that chess instruction might affect these skills in earlier grade levels. Similarly, for the combined construct—Observation and Credibility—students who received chess instruction benefited in the lower grades more than the higher grades. Students in grades 7-10 scored either less than or not differently from the control group on their observation and credibility skills.

There were no differences in Assumptions skills between the intervention and control groups across the board. The largest difference in Assumptions scores between the intervention and control group was in tenth grade in Year 2, which might imply that this is a more advanced skill that chess instruction could bring about in older students.

Overall posttest scores maintained the same patterns as the sub construct categories; students who received the chess instruction had higher scores than the control group in most of the lower grades, and not so much in higher grades.

## Section II 21<sup>st</sup> Century Skills

Teachers evaluated students' performance on each of eight 21<sup>st</sup> Century Skills via a retrospective pretest instrument. The eight skills were academic achievement, affective decision and judgment processes, critical thinking, strategic thinking, problem solving, systems thinking, cross-disciplinary thinking, and overall engagement.

The retrospective pretest design allowed the teacher to make a professional judgment about each student's performance at the start of the year compared to the end of the year. The assumption was that teachers knew each student's degree of progress in the eight 21<sup>st</sup> Century Skill areas because they had worked with these students for a full academic year. Such knowledge positioned them to accurately gauge the degree to which the students had grown over time. Another advantage of the retrospective pretest was that the teachers completed the assessment at one time using one fixed definition of a construct in order to assess both the pretest and posttest. The teacher-student familiarity and single assessment construct bolstered trustworthiness in this retrospective pretest design.

Table 6 shows the distribution of students by grade level and group. Control group data were not available for grades 2, 3, and 6 in Year 1 and for grades 7 and 8 in Year 3, and thus comparisons were not possible.

Table 6: Distribution of Students by Grade Level

Grade		Year 1		Year 2		Year 3	
		Control	Intervention	Control	Intervention	Control	Intervention
1	Count	22	47	-	-	-	-
	Percent	19.6%	9.0%	-	-	-	-
2	Count	0	69	19	20	18	23
	Percent	0.0%	13.2%	7.5%	5.5%	43.9%	56.1%
3	Count	0	69	0	20	32	71
	Percent	0.0%	13.2%	0.0%	5.5%	31.1%	68.9%
4	Count	49	158	117	26	31	146
	Percent	43.8%	30.2%	45.9%	7.1%	17.5%	82.5%
5	Count	41	113	38	171	53	209
	Percent	36.6%	21.6%	14.9%	46.8%	20.2%	79.8%
6	Count	0	67	37	67	50	227
	Percent	0.0%	12.8%	14.5%	18.4%	18.1%	81.9%
7	Count	-	-	23	40	0	25
	Percent	-	-	9.0%	11.0%	0.0%	100.0%
8	Count	-	-	21	21	0	7
	Percent	-	-	8.2%	5.8%	0.0%	100.0%
Total	Count	112	523	255	365	184	708
	Percent	100.0%	100.0%	100.0%	100.0%	20.6%	79.4%

## Overall Results Regarding 21<sup>st</sup> Century Skills Assessment

The unadjusted means<sup>3</sup> for each of the eight constructs of the 21<sup>st</sup> Century Skills showed a pattern of apparent success of the chess intervention group over the control group across all grade levels, when comparisons were possible. Tables 7-15 show the summary statistics for each of the eight constructs. Holding other variables constant, students exposed to chess were, on average, consistently rated by their teachers as having made improvements in each of these domains. When comparing the groups after adjusting for pretest performance, some differences diminished. Nevertheless, the most important finding from the first three years of chess implementation was that teachers reported via a retrospective pretest that their students grew over the course of the year.<sup>4</sup>

Chess instruction had the most presumed effect on five constructs: overall engagement, critical thinking, strategic thinking, systems thinking, and problem solving. Analyses were only conducted for grade levels that had sufficient numbers of students in both intervention and control groups. The analyses did not include the variable of “prior exposure to chess” as some students misinterpreted the question and answered “Yes” because they were currently experiencing chess in school though they had no prior exposure. Analysis of the influence of chess exposure (average minutes per week) on students was not possible because insufficient time logs were returned.

Table 7: Summary Statistics of Teachers’ Ratings of Academic Achievement

Academic Achievement							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.87	.11	-	-	-	-
	Intervention	4.08	.08	-	-	-	-
2	Control	-	-	4.10	.12	3.70	.11
	Intervention	-	-	3.56	.12	4.32	.09
3	Control	-	-	-	-	3.33	.13
	Intervention	-	-	-	-	3.30	.08
4	Control	4.19	.09	3.83	.05	3.17	.12
	Intervention	3.61	.05	3.80	.10	3.84	.06
5	Control	3.53	.08	3.25	.09	3.35	.08
	Intervention	3.52	.05	3.73	.04	3.63	.04
6	Control	-	-	4.39	.07	3.53	.08
	Intervention	-	-	4.25	.05	4.03	.04
7	Control	-	-	3.78	.13	-	-
	Intervention	-	-	3.80	.10	-	-
8	Control	-	-	4.28	.13	-	-
	Intervention	-	-	3.76	.12	-	-

<sup>3</sup> The unadjusted means are not shown in this document.

<sup>4</sup> Not considering prior exposure to chess or amount of exposure they may have had.

Table 8: Summary Statistics of Teachers' Ratings of Affective Decision &amp; Judgment Processes

Affective Decision & Judgment Processes							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.26	.141	-	-	-	-
	Intervention	3.73	.095	-	-	-	-
2	Control	-	-	3.07	.14	3.46	.09
	Intervention	-	-	3.34	.14	4.08	.08
3	Control	-	-	-	-	2.73	.11
	Intervention	-	-	-	-	3.25	.07
4	Control	4.17	.096	3.77	.05	2.94	.12
	Intervention	3.70	.051	4.01	.11	3.72	.06
5	Control	3.52	.072	3.01	.09	3.52	.08
	Intervention	3.63	.043	3.70	.04	3.59	.04
6	Control	-	-	4.07	.08	3.43	.08
	Intervention	-	-	4.01	.06	3.95	.04
7	Control	-	-	3.48	.10	-	-
	Intervention	-	-	3.70	.08	-	-
8	Control	-	-	4.13	.08	-	-
	Intervention	-	-	3.19	.08	-	-

Table 9: Summary Statistics of Teachers' Ratings of Critical Thinking

Critical Thinking							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.38	.14	-	-	-	-
	Intervention	3.84	.09	-	-	-	-
2	Control	-	-	3.37	.12	3.73	.11
	Intervention	-	-	3.30	.12	4.08	.10
3	Control	-	-	-	-	3.30	.14
	Intervention	-	-	-	-	3.26	.09
4	Control	4.12	.10	3.60	.06	3.01	.13
	Intervention	3.68	.05	3.92	.13	3.70	.06
5	Control	3.57	.07	2.84	.10	3.35	.08
	Intervention	3.63	.04	3.63	.05	3.69	.04
6	Control	-	-	4.12	.09	3.43	.08
	Intervention	-	-	3.98	.06	3.96	.04
7	Control	-	-	3.82	.08	-	-
	Intervention	-	-	3.83	.06	-	-
8	Control	-	-	3.88	.19	-	-
	Intervention	-	-	3.88	.17	-	-

Table 10: Summary Statistics of Teachers' Ratings of Strategic Thinking

Strategic Thinking							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.70	.16	-	-	-	-
	Intervention	3.82	.11	-	-	-	-
2	Control	-	-	3.25	.12	3.66	.12
	Intervention	-	-	3.41	.12	4.00	.10
3	Control	-	-	-	-	2.94	.11
	Intervention	-	-	-	-	3.37	.08
4	Control	4.13	.10	3.51	.05	2.95	.14
	Intervention	3.67	.05	3.77	.10	3.62	.07
5	Control	3.07	.08	2.97	.08	3.60	.07
	Intervention	3.46	.047	3.73	.04	3.56	.04
6	Control	-	-	4.29	.08	3.44	.08
	Intervention	-	-	4.07	.06	3.89	.04
7	Control	-	-	3.87	.08	-	-
	Intervention	-	-	3.98	.06	-	-
8	Control	-	-	2.51	.18	-	-
	Intervention	-	-	3.67	.16	-	-
	Intervention	-	-	-	-	-	-

Table 11: Summary Statistics of Teachers' Ratings of Problem Solving

Problem Solving							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.55	.14	-	-	-	-
	Intervention	3.89	.10	-	-	-	-
2	Control	-	-	3.58	.12	3.89	.10
	Intervention	-	-	3.70	.12	4.34	.09
3	Control	-	-	-	-	3.47	.14
	Intervention	-	-	-	-	3.20	.09
4	Control	4.24	.10	3.56	.05	3.09	.12
	Intervention	3.67	.05	3.71	.10	3.64	.06
5	Control	3.19	.08	3.18	.08	3.49	.08
	Intervention	3.54	.05	3.63	.04	3.62	.04
6	Control	-	-	4.22	.08	3.48	.08
	Intervention	-	-	4.07	.06	3.95	.04
7	Control	-	-	3.77	.09	-	-
	Intervention	-	-	3.92	.07	-	-
8	Control	-	-	3.15	.16	-	-
	Intervention	-	-	4.49	.14	-	-
	Intervention	-	-	-	-	-	-

Table 12: Summary Statistics of Teachers' Ratings of Systems Thinking

Systems Thinking							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.48	.15	-	-	-	-
	Intervention	3.79	.10	-	-	-	-
2	Control	-	-	3.14	.11	3.32	.07
	Intervention	-	-	3.47	.11	4.10	.06
3	Control	-	-	-	-	2.89	.10
	Intervention	-	-	-	-	3.09	.07
4	Control	4.24	.09	3.52	.05	2.94	.13
	Intervention	3.64	.05	3.36	.10	3.66	.06
5	Control	3.06	.08	2.92	.09	3.38	.08
	Intervention	3.61	.04	3.42	.04	3.53	.04
6	Control	-	-	4.18	.07	3.49	.08
	Intervention	-	-	3.99	.06	3.83	.04
7	Control	-	-	3.85	.09	-	-
	Intervention	-	-	3.91	.07	-	-
8	Control	-	-	-	-	-	-
	Intervention	-	-	-	-	-	-

Table 13: Summary Statistics of Teachers' Ratings of Cross-Disciplinary Thinking

Cross-Disciplinary Thinking							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.39	.14	-	-	-	-
	Intervention	3.89	.10	-	-	-	-
2	Control	-	-	3.35	.13	3.49	.11
	Intervention	-	-	3.42	.13	4.09	.09
3	Control	-	-	-	-	2.89	.12
	Intervention	-	-	-	-	3.07	.08
4	Control	4.14	.09	3.39	.04	2.91	.13
	Intervention	3.66	.05	3.28	.09	3.70	.06
5	Control	3.43	.07	2.90	.08	3.33	.07
	Intervention	3.59	.04	3.54	.04	3.61	.04
6	Control	-	-	4.13	.07	3.55	.09
	Intervention	-	-	4.02	.05	3.96	.04
7	Control	-	-	3.85	.09	-	-
	Intervention	-	-	3.91	.07	-	-
8	Control	-	-	2.54	.11	-	-
	Intervention	-	-	3.82	.10	-	-



Table 14: Summary Statistics of Teachers' Ratings of Overall Engagement

Overall Engagement							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.78	.13	-	-	-	-
	Intervention	3.98	.09	-	-	-	-
2	Control	-	-	3.56	.14	3.85	.07
	Intervention	-	-	3.67	.13	4.51	.06
3	Control	-	-	-	-	3.20	.15
	Intervention	-	-	-	-	3.42	.10
4	Control	4.30	.10	3.71	.05	3.15	.14
	Intervention	3.75	.05	3.72	.10	3.73	.06
5	Control	3.82	.52	3.55	.10	3.18	.10
	Intervention	4.42	.31	3.81	.05	3.63	.04
6	Control	-	-	4.22	.08	3.87	.12
	Intervention	-	-	4.14	.06	4.13	.05
7	Control	-	-	3.51	.13	-	-
	Intervention	-	-	3.91	.10	-	-
8	Control	-	-	3.90	.06	-	-
	Intervention	-	-	4.42	.05	-	-
	Intervention	-	-	-	-	-	-

Table 15: Summary Statistics of Teachers' Overall Student Performance on 21<sup>st</sup> Century Skills

Posttest Overall Score							
Grade	Group	Year 1		Year 2		Year 3	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	Control	3.59	.11	-	-	-	-
	Intervention	3.86	.08	-	-	-	-
2	Control	-	-	3.50	.07	3.90	.09
	Intervention	-	-	3.42	.07	3.99	.08
3	Control	-	-	-	-	3.23	.11
	Intervention	-	-	-	-	3.18	.07
4	Control	-	-	3.61	.04	3.61	.09
	Intervention	-	-	3.69	.08	3.63	.04
5	Control	4.21	.08	3.05	.06	3.49	.06
	Intervention	3.69	.04	3.65	.03	3.54	.03
6	Control	3.42	.08	4.20	.06	3.70	.08
	Intervention	3.67	.05	4.07	.04	3.90	.03
7	Control	-	-	3.76	.06	-	-
	Intervention	-	-	3.86	.05	-	-
8	Control	-	-	3.40	.06	-	-
	Intervention	-	-	3.70	.05	-	-

### Summary of Findings Related to 21<sup>st</sup> Century Skills

Overall, teachers in the intervention groups evaluated their students' 21<sup>st</sup> Century Skills with higher scores than students in the control groups in the eight skill areas. In Year 1, first and fifth grade students exposed to the chess intervention scored higher than the control group students did in almost every skill area, though fourth grade chess students typically scored a little lower than the control group students in most of the skill areas. In Year 2, the results varied across grade levels without many consistent patterns. However, in Year 3, when compared to the control groups, the intervention students had higher averages in every grade level included in the analysis for the following skills: Affective Decision & Judgment Processes, Systems Thinking, Cross-Disciplinary Thinking, and Overall Engagement.

### Section III

#### Teacher Survey Results

##### Demographics

A total of 62 teachers who used chess with their students responded to the survey. Of the respondents, 74% ( $n = 46$ ) were female and 22.6% ( $n = 14$ ) were male. Two teachers did not indicate gender. Forty percent of the teachers had been using chess for less than one year, another 40% had been using chess for one to two years, and about 20% had been using chess for three or more years.

Table 16. Distribution of Respondents by Grade Level Taught

Grade Level	Percent and sample size
2nd Grade	16% ( $n = 15$ )
3rd Grade	13% ( $n = 12$ )
4th Grade	16% ( $n = 15$ )
5th Grade	20% ( $n = 19$ )
6th Grade	13% ( $n = 12$ )
7th Grade	7% ( $n = 7$ )
8th Grade	6% ( $n = 6$ )
Other	10% ( $n = 10$ )
Total	100% ( $n = 96$ )

Note. The total sample size is larger than 62 because some teachers taught more than one grade.

Half of the respondents used chess during instruction, approximately 9% used chess in after-school chess clubs, and approximately 40% used chess in both settings. Regarding proficiency at chess playing, 42% indicated that they were somewhat proficient, 37% were moderately proficient, and 3% were extremely proficient. About a fifth (18%) indicated that they were not at all proficient.

Teachers used chess during instruction in several subject areas including English Language Arts, General Education, Gifted Education, Mathematics, Physical Education, Science, Social Studies, and Chess Programs. With 40% ( $n = 25$ ) of respondents using chess during math instruction, all other categories were combined in order to make a comparison of mathematics versus all other subjects. Both groups showed similar perceptions of their ability to incorporate chess into their instruction or programs. These proportions are presented in Figure 1.

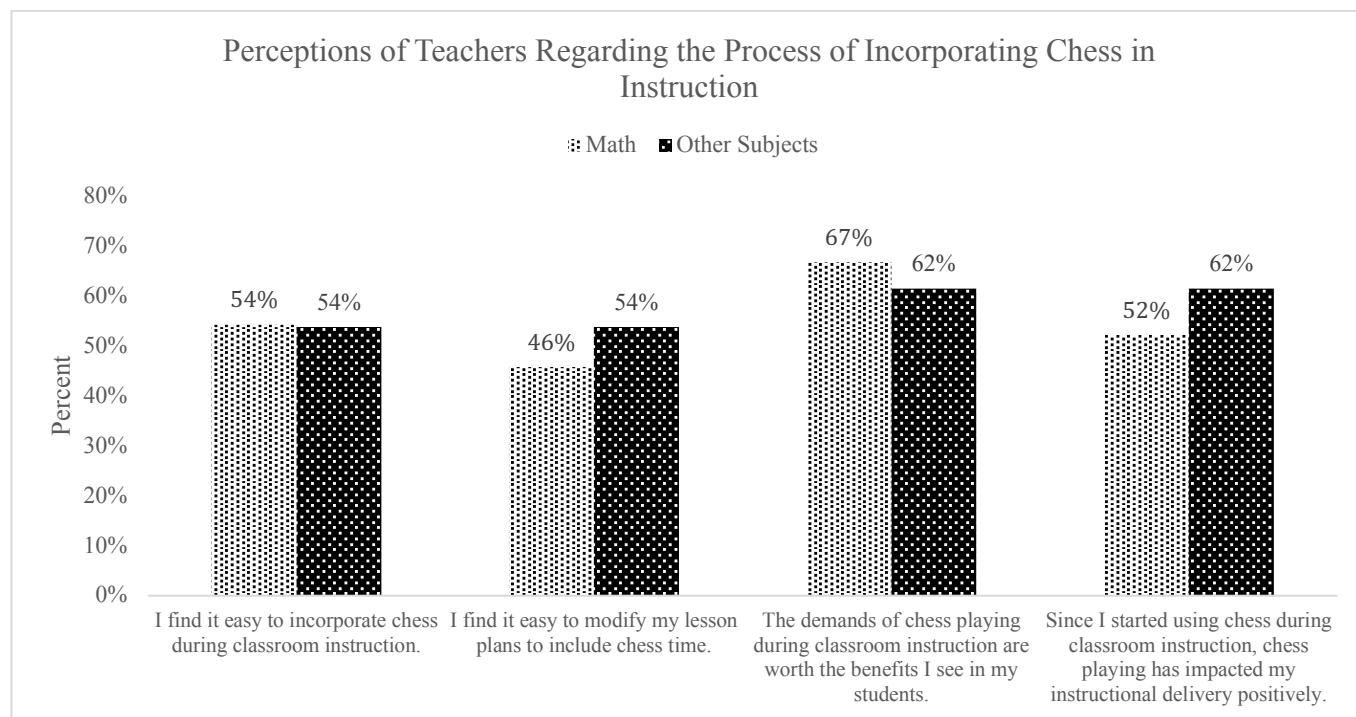


Figure 1. Perceptions of Teachers Regarding the Process of Incorporating Chess in Instruction

Equal percentages (54%) of math teachers and teachers of other subjects stated that they found it easy to incorporate chess during instruction. A slightly higher percentage of teachers of other subjects (54%) found it easy to modify their lesson plans to include chess time compared with teachers of mathematics (46%). Overall, 57% of the teachers indicated that chess playing during instruction had a positive impact on their instructional delivery. Also, a majority of the teachers (64%) felt that since they started using chess the demands placed on their instruction were well worth the benefits they saw in their students.

In an open-ended question, teachers who used chess during classroom instruction reported they struggled to find adequate time and feelings of stress influenced their method(s) of lesson delivery. Despite this, they reported they were more patient with students, lessons flowed more smoothly, and they were able to provide more purposeful, focused, and specific instruction. Using chess as an instructional strategy, teachers reported they saw an increase in experiential learning and critical thinking strategies due to the more focused instruction, which, in turn, improved critical and higher order thinking skills.

### Teachers' Overall Perceptions of the Benefits of Chess

The majority of teachers felt their students benefited socially (81%) and academically (73%) from the use of chess in instruction. Of particular importance was that 71% of the teachers indicated that they actually enjoy teaching with chess.

The teachers were asked to provide their perceptions regarding the observed benefits of chess as an instructional strategy. Table 17 shows the findings related to these perceived benefits of chess. Overall, the majority of teachers tended to view chess as providing positive benefits for their students. Ranked by percentage of agreement, teachers indicated the top five benefits were: students getting better at problem solving (78%); strategic thinking (75%); thinking critically (73%); decision making (64%); and being more interested in school (62%).

Table 17: Perceived Benefits of Chess by Teachers Since they Started Using Chess

Since I started teaching with chess...	Percent	<i>n</i>
1. My students are better at problem solving	78%	46
2. My students are getting better at strategic thinking	75%	44
3. My students are better at thinking critically	73%	43
4. My students are better at decision making	64%	37
5. My students are more interested in school	62%	36
6. My students are more engaged in class	59%	35
7. My students are better at socializing	59%	35
8. My students participate more in class	58%	34
9. My students' retention of complex or difficult concepts is improving	58%	34
10. My students are more interested in the subject/discipline	56%	33
11. My students' academic achievement has improved	49%	29
12. My students are better at time management	48%	28
13. My students are putting more effort in their work	47%	27
14. My students are better at organization	41%	24
15. My students are more interested in schoolwork	37%	22

Out of 15 benefits, five were chosen by less than half of the teachers. The five lowest ranked perceived benefits were: improvement in students' academic achievement (49%); better time management (48%); students putting more effort in their work (47%); and students being more interested in schoolwork (37%).

When asked about the benefits of chess to students in an open-ended question, teachers frequently conveyed improved critical thinking, strategic thinking, and problem solving. Teachers also reported experiencing improved behavior; a greater degree of attentiveness, engagement, and perseverance; and more thoughtful and reflective choices with students.

### How do Teachers Use ChessKid.com?

ChessKid.com is an online platform designed to help students learn the game of chess. The site is designed to "Empower children to learn the timeless game of Chess on the world's #1 Chess site for kids!" (ChessKid, 2018). The variety of learning tools that are available on the site "will keep kids motivated to learn and improve their Chess skills. More importantly, learning Chess will

give them skills that they can take with them throughout life: strategy, tactics, creativity, perseverance and calculated risk-taking” (ChessKid, 2018).

Most teachers (79%,  $n = 49$ ) used the independent practice feature, 73% ( $n = 45$ ) indicated that they used online videos and lessons, and 52% ( $n = 32$ ) used independent study. Less than 10% ( $n = 4$ ) of the sample stated that they did not use ChessKid.com. These findings are illustrated in Figure 2.

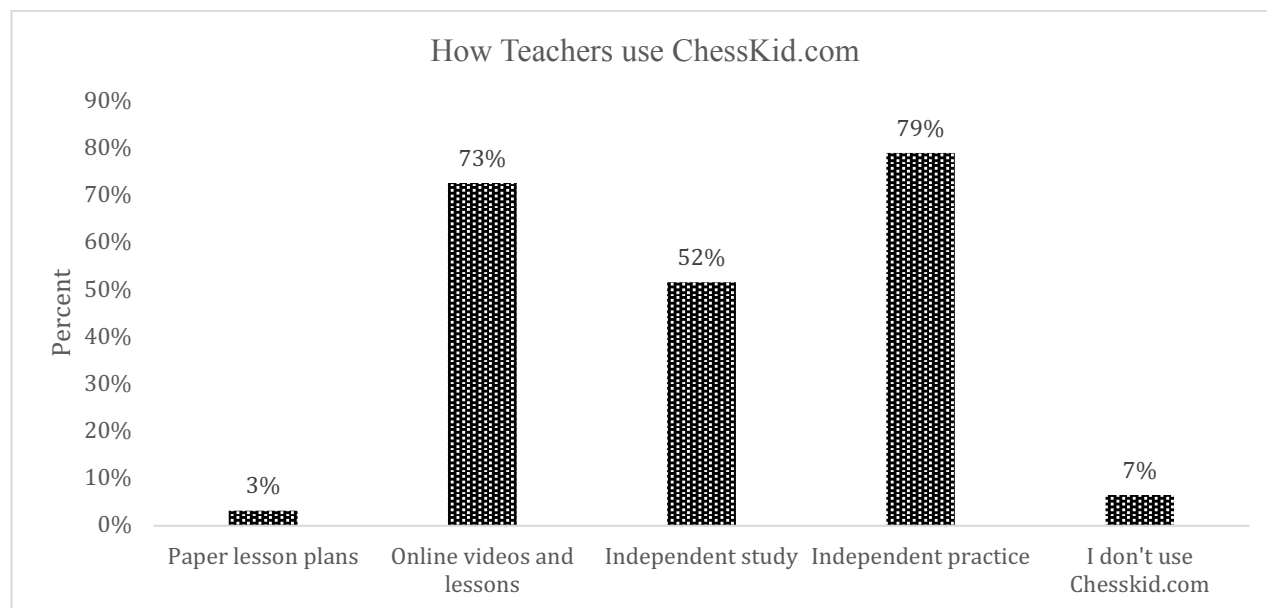


Figure 2. How Teachers use ChessKid.com

While a few teachers reported no challenges to incorporating chess in instruction, the most frequently reported challenge was the lack of time to seamlessly and meaningfully incorporate chess on a consistent and regular basis. Additional challenges included incorporating chess with a particular subject matter, lack of consistency and infrastructure, teacher confidence in chess instruction, and problems with technology. Other reported challenges were specific to working with students—accommodating students’ varying skill levels and overcoming student behavior.

When asked for any additional insights about chess instruction or changes in students, teachers made clear there was some disagreement as to where chess should be incorporated in instruction—homeroom versus physical education. Relatedly, they indicated that starting students at an early age would benefit students as they progressed through the grades where they experience increasingly advanced concepts. Teachers shared that students enjoyed playing chess once they learned how to play the game. They also believed critical thinking and decision-making skills increased after the introduction of chess. Positive impact on student behavior was another reported benefit of chess instruction. Students became more social and gracious at winning and losing. One teacher stated, “I watched students who were labeled ‘bad’ turn to chess and do GREAT things.” Additional encouraging remarks included teacher comments about how incorporating chess into instruction made them better teachers.

### **Summary of Findings Related to Teachers' Perceptions**

Teachers expressed that they felt the use of chess greatly benefits students, and though challenging, it was worth the extra time it took to implement chess in instruction and in the students' school day in general. Teachers reported large gains in their perceptions of students' abilities across a variety of cognitive and social abilities (Table 17). Not only did chess appear to benefit the students, but it also seemed to help the teachers. They shared that their classes flowed more smoothly and that students were more receptive to their pedagogy. Though we were not aware of any other chess tools teachers may have used, ChessKid.com appeared to be a preferred way for teachers to implement chess into their lessons, with only a small number of teachers (7%) indicating a preference for not utilizing this website. Overall, these factors indicate chess as an instructional strategy provided a positive and meaningful education experience for students and teachers.

## Section IV

### Student Survey Results

#### Demographics

A survey was administered to students who took part in chess programs in Alabama schools as part of the Chess in Schools initiative. A total of 1,286 students in grades 1 through 12 completed the survey. Two equivalent forms of the instrument were administered, one suitable for younger students in grades 1 to 4 (with emojis rather than numerical values and descriptions for response choices), and the other for students in grades 5 to 12.

Survey data were analyzed separately for grades 1-4 ( $n = 483$ ) and grades 5-12 ( $n = 803$ ). The distribution of students by grade level is presented in Table 18. Findings are reported for the two broad categories of grades rather than by each grade level. We did not seek to draw comparisons between the two grade level groups.

Table 18. Distribution of Students by Grade Level

Grade level	Grade	Frequency	Percent
Grades 1-4	1	36	7.5
	2	181	37.5
	3	97	20.1
	4	169	35.0
	Total	483	100.0
Grades 5-12	5	240	29.9
	6	153	19.1
	7	139	17.3
	8	78	9.7
	9	76	9.5
	10	106	13.2
	11	7	.9
	12	4	.5
Total	803	100.0	

The gender distribution of students is presented in Table 19. The proportion of males to females was identical for grades 1-4. In grades 5-12 there were slightly more males (54.2%) than females (45.8%). There were no gender differences in reporting the perceived benefits of chess. Both male and female students reported similar perceived benefits of chess playing.

Table 19. Gender Distribution of Students by Grade Level

Grade level	Gender	Frequency	Percent
Grades 1-4	Female	237	49.1
	Male	246	50.9
	Total	483	100.0
Grades 5-12	Female	368	45.8
	Male	435	54.2
	Total	803	100.0

### Use of ChessKid.com

Students reported practicing chess on ChessKid.com overall more in grades 5-12 (82.9%) than in grades 1-4 (67.4%), as displayed in Table 20. For the students who reported that their teacher used chess during instruction, 76% of students in grades 1-4 and 87% of students in grades 5-12 said they practiced on ChessKid.com.

Table 20. I Practice Chess on ChessKid.com

Grade level	No chess during instruction	Teacher uses chess during instruction	Total
Grades 1-4	54.1% ( <i>n</i> = 98)	75.5% ( <i>n</i> = 222)	67.4% ( <i>n</i> = 320)
Grades 5-12	60.7% ( <i>n</i> = 68)	86.5% ( <i>n</i> = 590)	82.9% ( <i>n</i> = 658)

Overall, 42% of students in grades 1-4 and 39% of students in grades 5-12 used ChessKid.com to practice chess sometimes or many times outside of school (See Table 21). Equal percentages (66%) of younger students and older students reported using ChessKid.com to practice or play chess at school other than during chess class, at least sometimes.

Table 21. Distribution of Responses Related to Use of ChessKid.com

Grade level	Response	I use ChessKid.com to practice or play chess outside of school	I use ChessKid.com to practice or play chess at school other than during chess class
Grades 1-4	Not at all	58.8% ( <i>n</i> = 281)	39.3% ( <i>n</i> = 186)
	Sometimes	28.7% ( <i>n</i> = 137)	34.7% ( <i>n</i> = 164)
	Many times	12.6% ( <i>n</i> = 60)	26.0% ( <i>n</i> = 123)
	Total	100.0% ( <i>n</i> = 478)	100.0% ( <i>n</i> = 473)
Grades 5-12	Not at all	60.4% ( <i>n</i> = 479)	33.4% ( <i>n</i> = 265)
	Sometimes	31.3% ( <i>n</i> = 248)	45.3% ( <i>n</i> = 359)
	Many times	8.3% ( <i>n</i> = 66)	21.3% ( <i>n</i> = 169)
	Total	100.0% ( <i>n</i> = 793)	100.0% ( <i>n</i> = 793)

### Chess Activity in Chess Clubs and Outside of School

In grades 1-4, 34.8% (*n* = 166) of the students participated in chess clubs, and in grades 5-12, 32% (*n* = 253) participated in chess clubs.

Table 22 shows the percentage distribution of students' responses regarding how often they played chess outside of school and at home. Overall, 34% of students in grades 1-4 and 38% in grades 5-12 stated they played chess with their friends outside of school sometimes or many times. A higher percentage of students in grades 1-4 (55%) reported playing chess at home than those in grades 5-12 (46%).



Table 22. Distribution of Responses Related to Playing Chess Outside of School

Grade level	Response	I play chess with my friends outside of school	I play chess at home
Grades 1-4	Not at all	69.4% ( <i>n</i> = 331)	44.8% ( <i>n</i> = 214)
	Sometimes	26.2% ( <i>n</i> = 125)	41.6% ( <i>n</i> = 199)
	Many times	4.4% ( <i>n</i> = 21)	13.6% ( <i>n</i> = 65)
	Total	100.0% ( <i>n</i> = 477)	100.0% ( <i>n</i> = 478)
Grades 5-12	Not at all	61.9% ( <i>n</i> = 491)	53.8% ( <i>n</i> = 427)
	Sometimes	33.9% ( <i>n</i> = 269)	36.9% ( <i>n</i> = 293)
	Many times	4.2% ( <i>n</i> = 33)	9.3% ( <i>n</i> = 74)
	Total	100.0% ( <i>n</i> = 793)	100.0% ( <i>n</i> = 794)

### Perceived Ability to Play Chess

Students in grades 1-4 generally rated their perceptions about ability to play chess higher than those in grades 5-12. Most of the students indicated that chess was a fun game, they enjoyed playing it, and they enjoyed playing it with their classmates. Also, most of the students in both grade level categories indicated that chess provided entertainment, a detail that may be important to foster student engagement.

Table 23. Students' Perceptions about Ability to Play Chess, by Grade Level

	Grades 1-4	Grades 5-12
Anyone can learn chess.	78.9% ( <i>n</i> = 355)	70.5% ( <i>n</i> = 549)
Chess is a fun game.	84.1% ( <i>n</i> = 398)	64.4% ( <i>n</i> = 508)
Chess is something I am good at.	71.4% ( <i>n</i> = 327)	49.0% ( <i>n</i> = 385)
Chess provides entertainment.	79.8% ( <i>n</i> = 375)	60.9% ( <i>n</i> = 479)
I am confident in my ability to play chess.	77.6% ( <i>n</i> = 346)	56.1% ( <i>n</i> = 439)
I enjoy playing chess.	82.7% ( <i>n</i> = 392)	64.7% ( <i>n</i> = 514)
I enjoy playing chess with my classmates.	83.4% ( <i>n</i> = 393)	72.1% ( <i>n</i> = 572)
I find chess confusing.	40.7% ( <i>n</i> = 185)	26.6% ( <i>n</i> = 209)
I put a lot of effort into my schoolwork.	90.4% ( <i>n</i> = 426)	82.5% ( <i>n</i> = 651)
My teachers make learning exciting.	82.4% ( <i>n</i> = 384)	62.5% ( <i>n</i> = 494)
When I am doing my schoolwork, I get very engaged.	71.7% ( <i>n</i> = 329)	59.9% ( <i>n</i> = 471)

Table 24 shows students' perceived benefits of chess for grades 1-4, broken down by gender. Students were asked to reflect on their experiences since they started learning chess in school. The top five items based on students' rankings were: I work harder on assignments (82.7%); I can now do the hardest work if I try (81%); I work better with my teachers at school (78%); My grades have improved (76%); and I am more excited about learning (76%). It is worth noting that a majority of the students indicated that all items listed in Table 7 had occurred. Generally, the percentages of females tended to be higher than males across most items.

Table 24. Perceived Benefits of Chess Grades 1-4 (Ordered by Rank)

<i>Since I started learning with chess...</i>	<b>Female</b>	<b>Male</b>	<b>Total</b>
I work harder on my school work.	84.5% (n = 196)	80.9% (n = 191)	82.7% (n = 387)
I can now do the hardest work if I try.	82.0% (n = 187)	79.2% (n = 183)	80.6% (n = 370)
I work better with my teachers at school.	83.0% (n = 191)	72.6% (n = 172)	77.7% (n = 363)
I feel more successful at school.	78.5% (n = 175)	76.4% (n = 178)	77.4% (n = 353)
My grades have improved.	80.0% (n = 180)	72.8% (n = 166)	76.4% (n = 346)
I am more excited about learning.	78.9% (n = 180)	73.7% (n = 174)	76.3% (n = 354)
I participate more in class.	74.2% (n = 170)	75.2% (n = 179)	74.7% (n = 349)
I can organize my life better.	74.6% (n = 167)	71.9% (n = 169)	73.2% (n = 336)
I work better with other students at school.	73.0% (n = 162)	69.7% (n = 163)	71.3% (n = 325)
I can organize my schoolwork better.	68.7% (n = 156)	69.9% (n = 167)	69.3% (n = 323)
I am better at managing time.	68.6% (n = 155)	66.7% (n = 158)	67.6% (n = 313)
I am more interested in school.	71.2% (n = 166)	63.4% (n = 151)	67.3% (n = 317)
I spend more time working with my classmates.	70.9% (n = 166)	63.5% (n = 153)	67.2% (n = 319)
I enjoy mathematics more.	67.2% (n = 156)	64.4% (n = 150)	65.8% (n = 306)
I am more interested in mathematics.	65.4% (n = 149)	61.7% (n = 145)	63.5% (n = 294)

As shown in Table 25, the five highest ranked items by students in grades 5-12 were: I can now do the hardest work if I try (65.7%); I work harder on my school work (65.7%); I feel more successful at school (64.4%); My grades have improved (59.5%); and I work better with my teachers at school (56.2%). Items that scored the lowest were: I enjoy Mathematics more (43.6%), I am more interested in Mathematics (41.9%), and I spend more time working with my classmates (41.5%). Similar to students in grades 1-4, the percentages of females tended to be higher than males for most of the items.

Table 25. Perceived Benefits of Chess Grades 5-12 (Ordered by Rank)

<i>Since I started learning with chess...</i>	<b>Female</b>	<b>Male</b>	<b>Total</b>
I can now do the hardest work if I try.	67.4% (n = 242)	64.3% (n = 270)	65.7% (n = 512)
I work harder on my school work.	69.1% (n = 248)	62.8% (n = 263)	65.7% (n = 511)
I feel more successful at school.	64.2% (n = 231)	64.6% (n = 272)	64.4% (n = 503)
My grades have improved.	59.7% (n = 216)	59.3% (n = 254)	59.5% (n = 470)
I work better with my teachers at school.	58.5% (n = 210)	54.2% (n = 228)	56.2% (n = 438)
I can organize my life better.	56.5% (n = 204)	55.1% (n = 236)	55.8% (n = 440)
I participate more in class.	57.4% (n = 209)	52.5% (n = 227)	54.8% (n = 436)
I can organize my schoolwork better.	57.9% (n = 210)	51.3% (n = 222)	54.3% (n = 432)
I work better with other students at school.	51.9% (n = 188)	54.8% (n = 235)	53.5% (n = 423)
I am better at managing time.	51.4% (n = 186)	49.4% (n = 211)	50.3% (n = 397)
I am more excited about learning.	50.8% (n = 182)	47.9% (n = 201)	49.2% (n = 383)
I am more interested in school.	52.7% (n = 192)	43.6% (n = 188)	47.8% (n = 380)
I enjoy mathematics more.	45.1% (n = 164)	42.5% (n = 183)	43.6% (n = 347)
I am more interested in mathematics.	41.7% (n = 151)	42.1% (n = 181)	41.9% (n = 332)
I spend more time working with my classmates.	44.1% (n = 160)	39.4% (n = 171)	41.5% (n = 331)

### Summary of Findings Related to Students' Perceptions

The findings in this section of the report pointed to a similar trend across all grade levels as well between genders. Of the 1,286 chess playing student respondents, not only did they enjoy playing chess at school, but many of them also played outside of class time or outside of school. A majority of the students had a positive view of their abilities to play the game. Both grade level groups had a positive view of chess. In addition, students in both grade categories reported

that their school work had improved since they started playing chess, including an increase in their abilities to complete difficult assignments and work harder on school work.