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

Report Prepared for:
The Alabama Chess in Schools Initiative[1]

By

George Chitiyo* Ph.D., Lisa Zagumny*, Ph.D.,
Ashley B. Akenson*, Ph.D., Michael Littrell*,
Krista Davis*, & Kevin Besnoy, Ph.D.[+]
*Tennessee Tech University
[+]University of Alabama

May 2020

---

This page intentionally left blank

**Table of Contents**

**Executive Summary**

**Introduction**

This report describes the results from Years 1-4 of a five-year program examining the use of chess in instruction in elementary and middle grades. The voluntary participants included teachers and their students in multiple schools across Alabama. With guidance from a private chess education consultant[2], the participating teachers developed a curriculum to incorporate chess in instruction to best meet the students' academic needs. The study employed a quasi-experimental control group design, where the control group included students who were not exposed to chess or any particular alternative teaching strategy. Part of the evaluation involved examining the relationship between the use of chess during core instruction and critical thinking skills (as well as other 21st Century Skills). 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 21st Century Skills as assessed by their teachers. In addition to these two measures being evaluated each year, during Year 3, teachers and students completed surveys that measured their perceptions of the influence of chess instruction.

**ACIS Program Description**

The Alabama Chess in Schools (ACIS) program focused on training teachers to use chess in the classroom to help teach curriculum standards, critical thinking, and 21st Century Skills. As a condition of receiving the grant-funded training and support, each participating school district signed a memorandum of understanding that outlined responsibilities for both the district and

---

[2] Jerry Nash is an education consultant for Chess in Schools, a 501(c)(3) public charity. The link to Chess in Schools is: https://chessinschools.us/

school levels. This included an agreement that the district would formally assign a "chess lead," and ensure that each participating school provided local oversight and coordination. Preference was given to school systems with no history of a chess program. Participating schools received grant support based on a selection process that evaluated buy-in from administrators within the same school feeder pattern (i.e., when their student cohorts stay relatively consistent as they matriculate from elementary to middle to high school). In accordance with state funding requirements, most of the participating schools received Title I funds and served student populations identified as at-risk. Schools' responsibilities included participation in research, reporting key milestones, and managing the program in their settings.

Administrators attended an orientation each March in order to better understand the program's timeline and expectations. Teachers new to the program attended a four-day professional development in the summer, prior to which the majority of participating teachers had little-to-no chess training. As a prerequisite to the training, teachers were given ChessKid[3] 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 English language arts, mathematics, social studies, science, 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. After the first summer, returning teachers participated in a two-day training that focused on chess skill development and lesson planning. Returning teachers also shared lessons learned with first year teachers during joint sessions.

---

[3] ChessKid is an online playing and tutoring site. 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

Teachers were given flexibility with chess implementation in their classrooms, but were required to include chess or chess-based lessons at least 1-2 hours per week and to start afterschool clubs. ACIS support included an online resource library of teacher-created lesson plans, on site visits, chess equipment, and ChessKid memberships for teachers and students. During training sessions, teachers were asked to reflect on what they would be teaching in their individual classrooms and to prepare lesson plans that connect chess with their particular grade level and subject standards.

Studies that examine chess in education generally suggest that learning and playing chess presumably increase executive and critical thinking skills simply by virtue of playing the game. Assuming this to be true, Chess in Schools sought to use a purposeful approach to facilitate the transference of these skills, with the hope that it would enable students to evoke the skills at will. Chess in Schools lessons were designed to utilize vocabulary and thinking skills from the game of chess to encourage students to apply them more generally, even outside of school. These lessons were then aligned to academic standards in English language arts, mathematics, social studies, science, critical thinking, and life skills.

When introducing academic lessons, teachers and students together defined, analyzed, and practiced the necessary thinking skills related to chess that were needed to solve a problem or achieve a goal in various academic and life situations. The protocol required teachers to use specific language to elicit "chess thinking" as they introduced lessons tied to academic standards and pragmatic tasks, calling attention to how chess players would think to maneuver such situations. In addition, standards-based academic lessons were 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 were used as models to assess problems, consider consequences, and make informed decisions.

Critical dimensions of successful program implementation are group training, teacher-student collaboration, and a foundation of buy-in by all stakeholders (including students, teachers, parents, and administrators at the school and district levels), without which the strength of the intervention is likely to fade. Additionally, it is important to have enthusiastic and committed consultants and trainers, who advocate for Chess in Schools to administrators, teachers, and funding sources.

## Report Structure

This report includes results from four years of implementation (2015-16, 2016-17, 2017-18, and 2018-19), and is divided into the following sections:

    I.    Critical Thinking Results: Years 1-3

   II.    21st Century Skills Results: Years 1-4

  III.    Teacher Survey Results: Year 3 (Spring 2018)

  IV.    Student Survey Results:  Year 3 (Spring 2018)

## Summary of Results

**Critical Thinking.** With respect to critical thinking, for induction, observation, and assumptions constructs, overall, there were small differences between the intervention and control groups, with the intervention group performing slightly better than the control group across most grades. With deduction, there was no clear pattern of advantage of one group over

another across the different grades. Overall posttest scores were higher for students who received chess instruction than the control group in most of the lower grades, and not so much in higher grades.

**21st Century Skills.** The means of each of the eight constructs of the 21st Century Skills showed apparent advantage of the chess intervention group over the control group across all grade levels, when comparisons were possible. All things being equal, students exposed to chess were, on average, consistently rated by their teachers as having made improvements in each of the eight domains.

**Teachers' Perceptions.** A total of 62 teachers participated in a survey to examine their perceptions of the use of chess in instruction. The teachers opined that the use of chess greatly benefited their students. Though challenging, they felt that chess use in instruction was worth the extra time it took to implement chess in instruction and in the students' school day in general. Teachers perceived large gains in the students' abilities across a variety of cognitive and social abilities. Not only did chess appear to benefit the students, it also seemed to help the teachers. They shared that their classes flowed more smoothly and that students were more receptive to their pedagogy. Teachers also indicated that exposing students to chess at an earlier age would benefit students as they progressed through the grades where they experience increasingly advanced concepts.

**Students' Perceptions.** A total of 1,286 students who received chess intervention indicated that they enjoyed playing chess. A large majority of the students expressed a positive view of their abilities to play the game. In addition, students in both grade categories (1-4 and 5-12) reported that their school work had improved since they started playing chess, including an increase in their abilities to complete difficult assignments and working harder on school work.

8

This page intentionally left blank

**Section I**

**Critical Thinking Results: Years 1-3**

Students' critical thinking skill development was assessed by the Cornell Critical Thinking Test during the first three years of the program. Students were administered a pretest at the beginning of each academic year and a posttest at the end of the academic year. Data were analyzed for students in grades 4-10. The analysis compared students who were exposed to chess (intervention) to those not exposed to chess (control) at each grade level, controlling for their pretest performance. The analysis focused mostly on patterns of mean differences rather than statistical significance.

Table 1.1 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 across the three years. During Year 1, comparisons could only be made for students in grades 4-8. Beginning Year 2, data were also available for grades 9 and 10. 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, hence the results from that year should be interpreted with extreme caution, particularly for grades 8-10.

Table 1.1. Distribution of Students by Grade and Group

| Grade | Year 1 Control | Year 1 Intervention | Year 2 Control | Year 2 Intervention | Year 3 Control | Year 3 Intervention | Total Control | Total Intervention |
|---|---|---|---|---|---|---|---|---|
| 4 | 41 (28%) | 101 (71%) | 35 (30%) | 79 (69%) | 36 (19%) | 153 (81%) | 112 (25%) | 333 (74%) |
| 5 | 21 (31%) | 45 (68%) | 23 (13%) | 146 (86%) | 37 (19%) | 153 (80%) | 81 (19%) | 344 (80%) |
| 6 | 21 (32%) | 43 (67%) | 10 (21%) | 36 (78%) | 50 (35%) | 91 (64%) | 81 (32%) | 170 (67%) |
| 7 | 20 (51%) | 19 (48%) | 17 (47%) | 19 (52%) | 12 (9%) | 119 (90%) | 49 (23%) | 157 (76%) |
| 8 | 14 (21%) | 51 (78%) | 18 (47%) | 20 (52%) | 3 (16%) | 15 (83%) | 35 (28%) | 86 (71%) |
| 9 | - | - | 24 (58%) | 17 (41%) | 0 (0%) | 15 (100%) | 24 (42%) | 32 (57%) |
| 10 | - | - | 10 (35%) | 18 (64%) | 2 (10%) | 17 (89%) | 12 (25%) | 35 (74%) |
| Total | 117 (31%) | 259 (68%) | 137 (29%) | 335 (71%) | 140 (19%) | 563 (80%) | 394 (25%) | 1157 (74%) |

*Note*. The percentages shown are for row percentages, i.e., percentages within each grade.

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 construct, and patterns of differences between the means are examined. Significance values of differences among means of the intervention and control groups are provided for the combined sample from the three years.

Tables 1.2-1.6 show the descriptive statistics for the intervention and control groups at each grade level for overall posttest scores as well as the five constructs measured by the Cornell Critical Thinking Test. The tables also include F statistics and p-values associated with significance tests of mean differences, controlling for pretest scores[4].

**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 1.2, for this construct, overall, the aggregated data from Years 1–3 show a pattern of very similar group means between the intervention and control groups, with the intervention group having a slight edge over the control group across most grades. Comparisons by year are shown in Appendix 1A. In grade 10, the control group

---

[4] Analysis of covariance approach was used to generate the estimated marginal means and to test for mean differences.

performed significantly better ($F = 7.61$, $p = .008$) than the intervention group in terms of

induction.

Table 1.2. Induction Score Summary Statistics by Grade and Group

| Grade | Group | Mean | Std. Error | F | *p*-value |
|---|---|---|---|---|---|
| 4 | Control | 11.7 | .34 | 2.76 | .098 |
| | Intervention | 12.3 | .20 | | |
| 5 | Control | 12.9 | .39 | .90 | .345 |
| | Intervention | 13.3 | .19 | | |
| 6 | Control | 12.2 | .39 | .15 | .702 |
| | Intervention | 12.3 | .27 | | |
| 7 | Control | 13.7 | .51 | 3.50 | .063 |
| | Intervention | 12.6 | .29 | | |
| 8 | Control | 13.1 | .61 | .002 | .964 |
| | Intervention | 13.0 | .39 | | |
| 9 | Control | 13.2 | .64 | 1.58 | .215 |
| | Intervention | 14.3 | .55 | | |
| 10 | Control | 14.6 | .88 | 7.61 | .008* |
| | Intervention | 11.8 | .51 | | [2.81, 3.23] |

*Difference is significant at the .05 alpha level; 95% confidence interval included.

**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.

Table 1.3 shows that the intervention groups' adjusted means across all grade levels

(except 6 and 7) were higher than the control group, albeit most differences were not statistically

significant. The intervention group means were significantly higher than the control group in

grades 5 and 9. Comparisons by year are shown in Appendix 1B.

Table 1.3. Observation and Credibility Score Summary Statistics by Grade and Group

| Grade | Group | Mean | Std. Error | F | p-value |
|---|---|---|---|---|---|
| 4 | Control | 9.6 | .28 | .49 | .484 |
| | Intervention | 9.8 | .17 | | |
| 5 | Control | 9.8 | .33 | 4.59 | .033* [.75, .85] |
| | Intervention | 10.6 | .16 | | |
| 6 | Control | 9.9 | .33 | .64 | .426 |
| | Intervention | 9.5 | .23 | | |
| 7 | Control | 10.6 | .45 | .93 | .335 |
| | Intervention | 10.1 | .25 | | |
| 8 | Control | 9.8 | .54 | 1.24 | .269 |
| | Intervention | 10.5 | .35 | | |
| 9 | Control | 10.2 | .55 | 5.12 | .028* [1.43, 1.97] |
| | Intervention | 11.9 | .47 | | |
| 10 | Control | 10.2 | .80 | 1.11 | .299 |
| | Intervention | 11.2 | .46 | | |

*Difference is significant at the .05 alpha level; 95% confidence interval included.


**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 1.4. For this construct, overall, there was no clear

pattern of advantage of one group over another across the different grades, aside from grade 4.

Fourth grade students in the intervention group scored higher than the control, and this difference

was statistically significant. Comparisons by year are shown in Appendix 1C.

Table 1.4. Deduction Score Summary Statistics by Grade and Group

| Grade | Group | Mean | Std. Error | F | p-value |
|---|---|---|---|---|---|
| 4 | Control | 7.1 | .31 | 6.10 | .014* |
|   | Intervention | 8.0 | .18 |   | [.85, .95] |
| 5 | Control | 8.4 | .33 | .002 | .968 |
|   | Intervention | 8.4 | .17 |   |   |
| 6 | Control | 7.4 | .34 | .008 | .930 |
|   | Intervention | 7.4 | .25 |   |   |
| 7 | Control | 8.0 | .38 | 1.04 | .309 |
|   | Intervention | 7.6 | .22 |   |   |
| 8 | Control | 9.1 | .56 | .008 | .931 |
|   | Intervention | 9.1 | .36 |   |   |
| 9 | Control | 8.4 | .84 | .09 | .767 |
|   | Intervention | 8.0 | .66 |   |   |
| 10 | Control | 10.3 | 1.34 | 1.78 | .192 |
|   | Intervention | 8.4 | .54 |   |   |

*Difference is significant at the .05 alpha level; 95% confidence interval included.

## Assumptions

Assumptions refer 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 1.5. Intervention group means were about the same as the control group means across grade levels except for grade 9. Comparisons by year are shown in Appendix 1D.

Table 1.5. Assumptions Score Summary Statistics by Grade and Group

| Grade | Group | Mean | Std. Error | F | p-value |
|---|---|---|---|---|---|
| 4 | Control | 3.2 | .18 | 1.93 | .165 |
|   | Intervention | 3.5 | .10 |   |   |
| 5 | Control | 3.5 | .19 | 1.34 | .248 |
|   | Intervention | 3.7 | .09 |   |   |
| 6 | Control | 3.5 | .22 | .12 | .731 |
|   | Intervention | 3.6 | .16 |   |   |
| 7 | Control | 3.5 | .27 | .02 | .878 |
|   | Intervention | 3.6 | .15 |   |   |
| 8 | Control | 3.1 | .30 | 1.67 | .199 |
|   | Intervention | 3.6 | .19 |   |   |
| 9 | Control | 4.5 | .55 | 2.05 | .162 |
|   | Intervention | 3.5 | .44 |   |   |
| 10 | Control | 5.0 | 1.10 | .01 | .919 |
|   | Intervention | 5.0 | .42 |   |   |

**Overall Posttest Score**

Across most grade levels, except grades 6 and 7, the overall posttest scores were higher

for the intervention group than the control group. In fact, these differences were statistically

significant in grades 4 and 5. Comparisons by year are shown in Appendix 1E.

Table 1.6. Overall Posttest Score Summary Statistics by Grade and Group

| Grade | Group | Mean | Std. Error | F | *p*-value |
|---|---|---|---|---|---|
| 4 | Control | 30.0 | .74 | 5.07 | .025* |
| | Intervention | 31.9 | .43 | | [1.79, 2.01] |
| 5 | Control | 32.5 | .84 | 9.15 | .003* |
| | Intervention | 35.4 | .41 | | [2.77, 3.03] |
| 6 | Control | 31.6 | .78 | .76 | .384 |
| | Intervention | 30.9 | .54 | | |
| 7 | Control | 34.4 | .95 | 1.64 | .202 |
| | Intervention | 33.0 | .53 | | |
| 8 | Control | 32.4 | 1.24 | .38 | .540 |
| | Intervention | 33.3 | .79 | | |
| 9 | Control | 34.2 | 1.76 | .28 | .596 |
| | Intervention | 35.4 | 1.51 | | |
| 10 | Control | 32.2 | 2.05 | .45 | .505 |
| | Intervention | 33.8 | 1.18 | | |

*Difference is significant at the .05 alpha level; 95% confidence interval included.

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

For the induction construct, overall, the aggregated data from Years 1-3 show very little

difference between the intervention and control group means, with the intervention group having

a slight edge over the control group across most grades. For observation and credibility, students

exposed to the chess intervention had generally higher scores than those who were not. With

regard to deduction, there was no clear pattern of advantage of one group over another across the

different grades. Regarding assumptions, students exposed to chess generally performed better

than those who were not. Overall posttest scores maintained the same patterns as the sub

construct categories; students who received chess instruction had higher scores than the control

group in most of the lower grades, and not so much in higher grades.

**Section II**

**21st Century Skills Results: Years 1-4**

Teachers evaluated students' performance on each of the eight 21st Century Skills via a retrospective pretest instrument. The eight skills are 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 at the end of the academic year comparing each student's performance at the start of the year with performance at the end of the year. The assumption of the retrospective pretest was that teachers knew each student's degree of progress in the eight 21st Century Skills 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 progressed 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 both bolstered the trustworthiness of the data obtained from the teachers.

Table 2.1 shows the distribution of students by grade level and group. The sample for each grade level is pooled across different years. Appendix 2A shows the distribution of students in each of the grade levels during each of the different years.

Table 2.1. Distribution of Students by Grade and Group

| Grade | Control | Intervention | Total |
|-------|---------|--------------|-------|
| 1 | 22 (31%) | 47 (68%) | 69 (100%) |
| 2 | 37 (46%) | 43 (53%) | 80 (100%) |
| 3 | 69 (28%) | 176 (71%) | 245 (100%) |
| 4 | 217 (38%) | 351 (61%) | 568 (100%) |
| 5 | 158 (23%) | 530 (77%) | 688 (100%) |
| 6 | 87 (22%) | 294 (77%) | 381 (100%) |
| 7 | 23 (36%) | 40 (63%) | 63 (100%) |
| 8 | 21 (50%) | 21 (50%) | 42 (100%) |

## Overall Results Regarding 21st Century Skills Assessment

The means of each of the eight constructs of the 21st Century Skills showed a seeming pattern of success of the chess intervention group over the control group across all grade levels, when comparisons were possible. The means were computed while adjusting for pretest ratings on each of the skills. Tables 2.2-2.9 and Figures 2.1-2.8 show the summary statistics for each of the eight constructs with samples from all four years combined, including significance values. 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. Perhaps the most important finding from the four years of chess implementation was that teachers reported via a retrospective pretest that their students grew over the course of the year. Though, it is worth noting that each year was treated as a cross sectional unit, that is, the analysis did not take into account the amount of exposure to chess students may have had in previous years because of the lack of reliability of the teachers' time logs.

Generally, Tables 2.2-2.9 and Figures 2.1-2.8 show that the intervention group performed as well as or higher than the control group across all grade levels. Albeit some of the differences were small, the pattern of adjusted mean differences was consistent across grade levels. In grade 8, the control group tended to score significantly higher than the intervention group on academic

achievement and decision and judgment processes. Overall, teachers in the intervention group tended to score their students' 21st Century Skills higher than students in the control group in the eight domains. Though not all of the differences were statistically significant, there may be promising practical implications.

## Academic Achievement

Table 2.2. Summary Statistics of Teachers' Ratings of Academic Achievement

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 2.50 | .15 | .109 |
| | Intervention | 2.80 | .10 | |
| 2 | Control | 3.84 | .08 | .140 |
| | Intervention | 4.02 | .08 | |
| 3 | Control | 3.52 | .07 | .019* |
| | Intervention | 3.73 | .04 | [.20, .22] |
| 4 | Control | 3.55 | .04 | .493 |
| | Intervention | 3.59 | .03 | |
| 5 | Control | 3.18 | .05 | .000* |
| | Intervention | 3.53 | .03 | [.34, .36] |
| 6 | Control | 3.85 | .06 | .001* |
| | Intervention | 4.08 | .03 | [.22, .24] |
| 7 | Control | 3.77 | .12 | .860 |
| | Intervention | 3.80 | .09 | |
| 8 | Control | 4.28 | .12 | .004* |
| | Intervention | 3.75 | .11 | [.46, .60] |

*Difference is significant at the .05 alpha level; 95% confidence interval included.



Mean Teacher Ratings on Academic Achievement

| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|---|---|---|---|---|---|---|---|
| Control | 2.5 | 3.8 | 3.5 | 3.6 | 3.2 | 3.9 | 3.8 | 4.3 |
| Intervention | 2.8 | 4.0 | 3.7 | 3.6 | 3.5 | 4.1 | 3.8 | 3.8 |
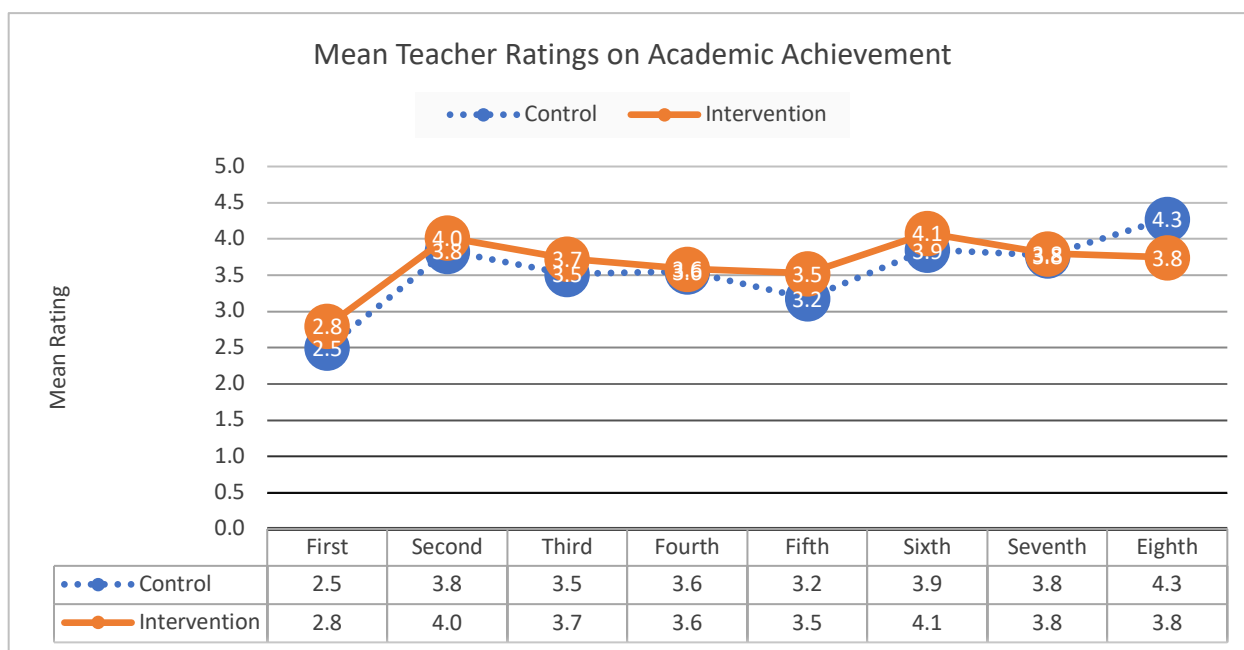
*Figure 2.1.* Mean teacher ratings on academic achievement.

## Affective Decision and Judgment Processes

Table 2.3. Summary Statistics of Teachers' Ratings of Affective Decision & Judgment Processes

| Grade | Group | Mean | Std. Error | Significance |
|-------|-------|------|------------|--------------|
| 1 | Control | 2.58 | 0.08 | .011* |
| | Intervention | 2.85 | 0.05 | [.24, .30] |
| 2 | Control | 3.24 | 0.07 | .000* |
| | Intervention | 3.73 | 0.07 | [.46, .52] |
| 3 | Control | 3.32 | 0.08 | .000* |
| | Intervention | 3.68 | 0.05 | [.34, .38] |
| 4 | Control | 3.47 | 0.04 | .691 |
| | Intervention | 3.49 | 0.03 | |
| 5 | Control | 3.31 | 0.05 | .243 |
| | Intervention | 3.39 | 0.03 | |
| 6 | Control | 3.68 | 0.06 | .000* |
| | Intervention | 3.97 | 0.03 | [.28, .30] |
| 7 | Control | 3.48 | 0.10 | .100 |
| | Intervention | 3.69 | 0.07 | |
| 8 | Control | 4.12 | 0.08 | .000* |
| | Intervention | 3.18 | 0.07 | [.89, .99] |

*Difference is significant at the .05 alpha level; 95% confidence interval included.



| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|-------|--------|-------|--------|-------|-------|---------|--------|
| Control | 2.6 | 3.2 | 3.3 | 3.5 | 3.3 | 3.7 | 3.5 | 4.1 |
| Intervention | 2.9 | 3.7 | 3.7 | 3.5 | 3.4 | 4.0 | 3.7 | 3.2 |

*Figure 2.2.* Mean teacher ratings on decision and judgment processes.

# Critical Thinking

Table 2.4. Summary Statistics of Teachers' Ratings of Critical Thinking

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 2.84 | .08 | .141 |
| | Intervention | 2.69 | .05 | |
| 2 | Control | 3.52 | .08 | .083 |
| | Intervention | 3.73 | .07 | |
| 3 | Control | 3.56 | .07 | .193 |
| | Intervention | 3.68 | .05 | |
| 4 | Control | 3.42 | .04 | .542 |
| | Intervention | 3.46 | .03 | |
| 5 | Control | 3.20 | .05 | .000* |
| | Intervention | 3.45 | .02 | [.24, .26] |
| 6 | Control | 3.68 | .06 | .000* |
| | Intervention | 3.97 | .03 | [.28, .30] |
| 7 | Control | 3.82 | .08 | .944 |
| | Intervention | 3.82 | .06 | |
| 8 | Control | 3.89 | .18 | 1.00 |
| | Intervention | 3.89 | .16 | |

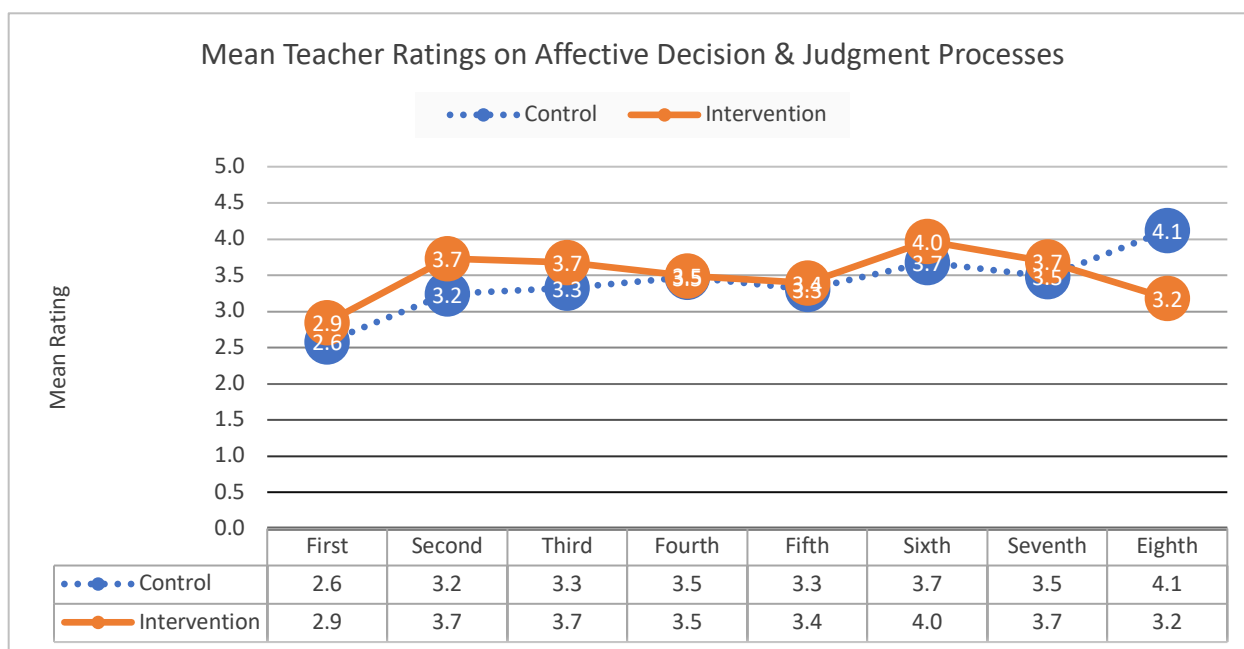*Difference is significant at the .05 alpha level; 95% confidence interval included.



Mean Teacher Ratings on Critical Thinking

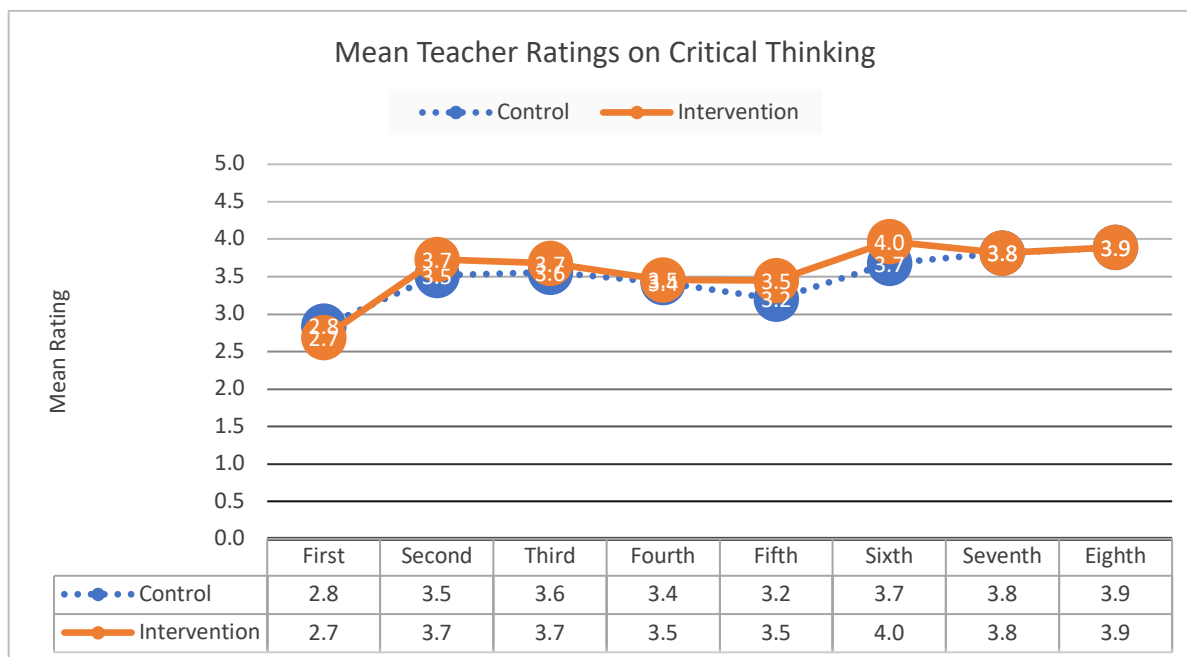| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|---|---|---|---|---|---|---|---|
| Control | 2.8 | 3.5 | 3.6 | 3.4 | 3.2 | 3.7 | 3.8 | 3.9 |
| Intervention | 2.7 | 3.7 | 3.7 | 3.5 | 3.5 | 4.0 | 3.8 | 3.9 |

*Figure 2.3*. Mean teacher ratings on critical thinking.

## Strategic Thinking

Table 2.5. Summary Statistics of Teachers' Ratings of Strategic Thinking

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 2.64 | .12 | .005* |
| | Intervention | 3.08 | .08 | [.39, .49] |
| 2 | Control | 3.45 | .08 | .023* |
| | Intervention | 3.72 | .07 | [.24, .30] |
| 3 | Control | 3.38 | .07 | .001* |
| | Intervention | 3.68 | .04 | [.29, .31] |
| 4 | Control | 3.38 | .04 | .058 |
| | Intervention | 3.50 | .03 | |
| 5 | Control | 3.24 | .05 | .000* |
| | Intervention | 3.70 | .02 | [.46, .47] |
| 6 | Control | 3.75 | .06 | .007* |
| | Intervention | 3.94 | .03 | [.18, .20] |
| 7 | Control | 3.86 | .07 | .265 |
| | Intervention | 3.97 | .05 | |
| 8 | Control | 2.50 | .17 | .000* |
| | Intervention | 3.66 | .16 | [1.06, 1.26] |

*Difference is significant at the 0.05 alpha level



### Mean Teacher Ratings on Strategic Thinking

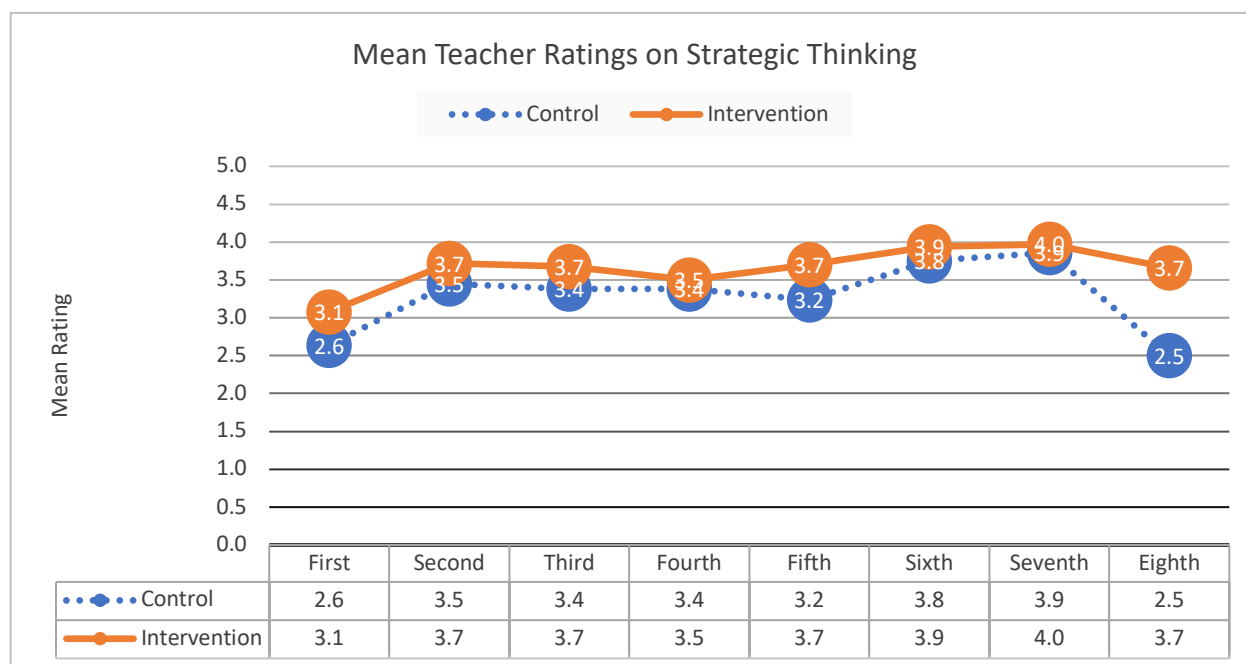| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|---|---|---|---|---|---|---|---|
| Control | 2.6 | 3.5 | 3.4 | 3.4 | 3.2 | 3.8 | 3.9 | 2.5 |
| Intervention | 3.1 | 3.7 | 3.7 | 3.5 | 3.7 | 3.9 | 4.0 | 3.7 |

*Figure 2.4.* Mean teacher ratings on strategic thinking.

## Problem Solving

Table 2.6. Summary Statistics of Teachers' Ratings of Problem Solving

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 3.26 | .14 | .010* |
| | Intervention | 3.72 | .09 | [.40, .52] |
| 2 | Control | 3.74 | .07 | .008* |
| | Intervention | 4.03 | .07 | [.26, .32] |
| 3 | Control | 3.59 | .09 | .546 |
| | Intervention | 3.65 | .05 | |
| 4 | Control | 3.62 | .04 | .230 |
| | Intervention | 3.68 | .03 | |
| 5 | Control | 3.35 | .04 | .000* |
| | Intervention | 3.66 | .02 | [.31, .32] |
| 6 | Control | 3.76 | .06 | .002* |
| | Intervention | 3.98 | .03 | [.21, .23] |
| 7 | Control | 3.76 | .09 | .212 |
| | Intervention | 3.90 | .06 | |
| 8 | Control | 3.15 | .15 | .000* |
| | Intervention | 4.48 | .14 | [1.24, 1.42] |

*Difference is significant at the .05 alpha level; 95% confidence interval included.



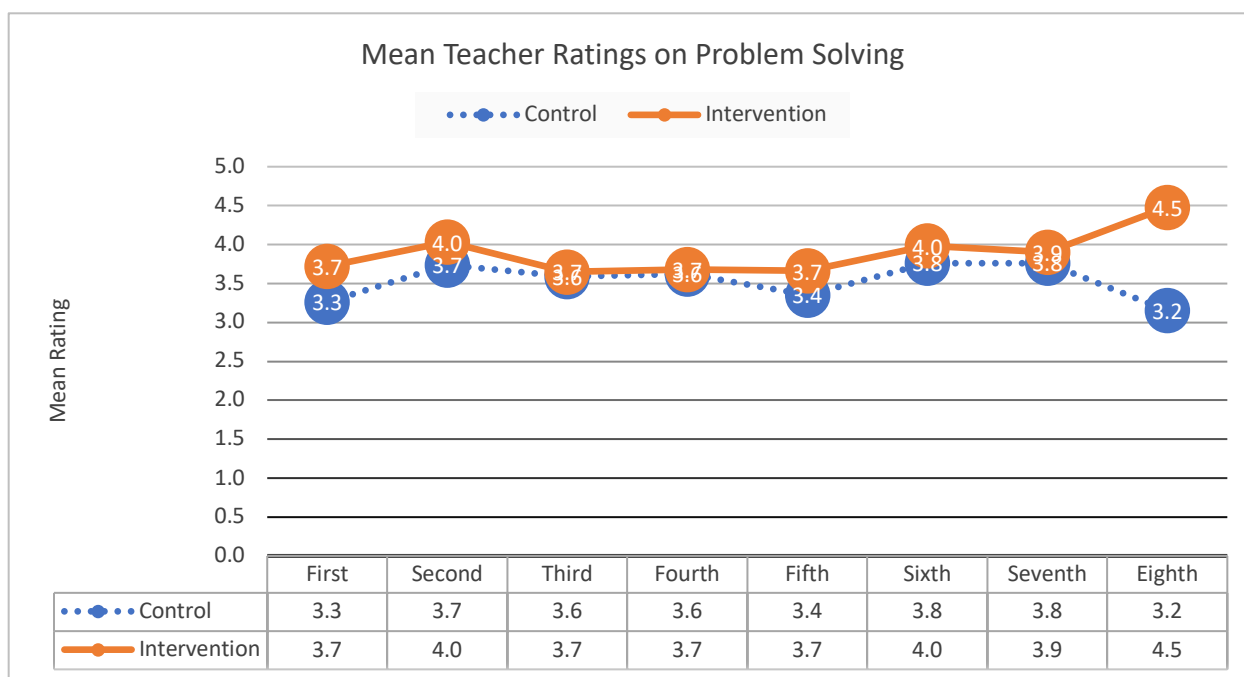| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|---|---|---|---|---|---|---|---|
| Control | 3.3 | 3.7 | 3.6 | 3.6 | 3.4 | 3.8 | 3.8 | 3.2 |
| Intervention | 3.7 | 4.0 | 3.7 | 3.7 | 3.7 | 4.0 | 3.9 | 4.5 |

*Figure 2.5*. Mean teacher ratings on problem solving.

## Systems Thinking

Table 2.7. Summary Statistics of Teachers' Ratings of Systems Thinking

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 3.84 | .11 | .480 |
| | Intervention | 3.74 | .07 | |
| 2 | Control | 3.23 | .06 | .000* |
| | Intervention | 3.79 | .06 | [.53, .59] |
| 3 | Control | 3.25 | .08 | .000* |
| | Intervention | 3.65 | .05 | [.38, .42] |
| 4 | Control | 3.58 | .04 | .200* |
| | Intervention | 3.65 | .03 | [.06, .08] |
| 5 | Control | 3.32 | .05 | .044* |
| | Intervention | 3.44 | .02 | [.11, .13] |
| 6 | Control | 3.74 | .05 | .038* |
| | Intervention | 3.88 | .03 | [.13, .15] |
| 7 | Control | 3.84 | .09 | .544 |
| | Intervention | 3.91 | .06 | |
| 8 | Control | - | - | - |
| | Intervention | - | - | |

*Difference is significant at the .05 alpha level; 95% confidence interval included.



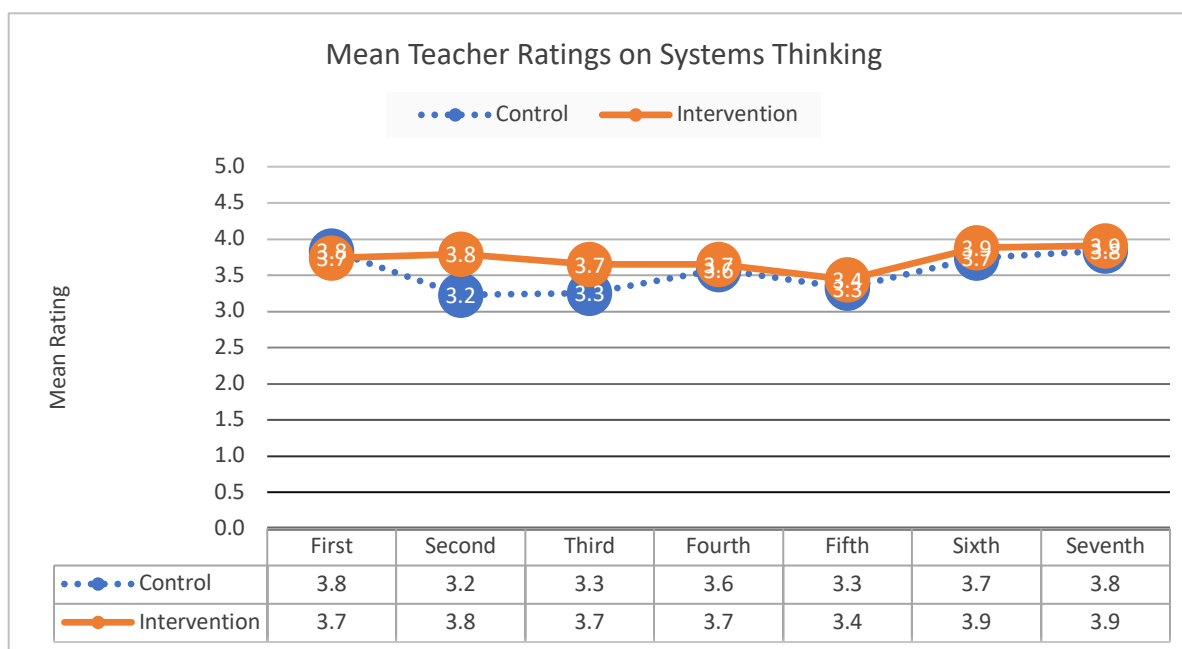| | First | Second | Third | Fourth | Fifth | Sixth | Seventh |
|---|---|---|---|---|---|---|---|
| Control | 3.8 | 3.2 | 3.3 | 3.6 | 3.3 | 3.7 | 3.8 |
| Intervention | 3.7 | 3.8 | 3.7 | 3.7 | 3.4 | 3.9 | 3.9 |

*Figure 2.6.* Mean teacher ratings on systems thinking.

## Cross Disciplinary Thinking

Table 2.8. Summary Statistics of Teachers' Ratings of Cross Disciplinary Thinking

| Grade | Group | Mean | Std. Error | Significance |
|-------|-------|------|-----------|--------------|
| 1 | Control | 3.84 | .11 | .451 |
|   | Intervention | 3.74 | .07 | |
| 2 | Control | 3.23 | .06 | .002* |
|   | Intervention | 3.79 | .06 | [.53, .59] |
| 3 | Control | 3.25 | .08 | .002* |
|   | Intervention | 3.65 | .05 | [.38, .42] |
| 4 | Control | 3.58 | .04 | .115 |
|   | Intervention | 3.65 | .03 | |
| 5 | Control | 3.32 | .05 | .001* |
|   | Intervention | 3.44 | .02 | [.11, .13] |
| 6 | Control | 3.74 | .05 | .004* |
|   | Intervention | 3.88 | .03 | [.13, .15] |
| 7 | Control | 3.84 | .09 | .541 |
|   | Intervention | 3.91 | .06 | |
| 8 | Control | - | - | - |
|   | Intervention | - | - | |

*Difference is significant at the .05 alpha level; 95% confidence interval included.
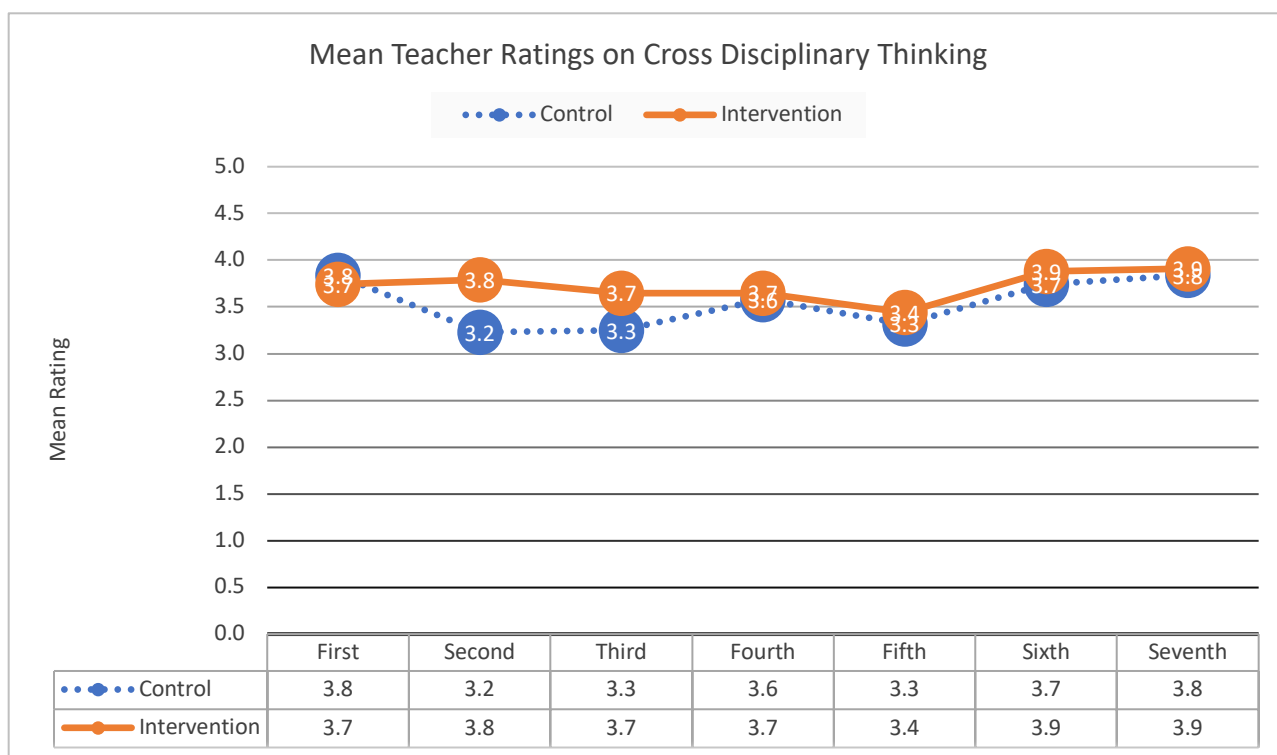


Figure 2.7. Mean teacher ratings on cross disciplinary thinking.

## Overall Engagement

Table 2.9. Summary Statistics of Teachers' Ratings of Overall Engagement

| Grade | Group | Mean | Std. Error | Significance |
|---|---|---|---|---|
| 1 | Control | 3.81 | .10 | .299 |
| | Intervention | 3.95 | .07 | |
| 2 | Control | 3.68 | .07 | .000* |
| | Intervention | 4.12 | .07 | [.41, .47] |
| 3 | Control | 3.20 | .08 | .000* |
| | Intervention | 3.79 | .05 | [.57, .61] |
| 4 | Control | 3.82 | .04 | .393 |
| | Intervention | 3.78 | .03 | |
| 5 | Control | 3.55 | .15 | .026* |
| | Intervention | 3.94 | .08 | [.37, .41] |
| 6 | Control | 4.05 | .07 | .333 |
| | Intervention | 4.13 | .04 | |
| 7 | Control | 3.51 | .13 | .019* |
| | Intervention | 3.90 | .09 | [.33, .45] |
| 8 | Control | 3.89 | .05 | .000* |
| | Intervention | 4.42 | .05 | [.50, .56] |

*Difference is significant at the .05 alpha level; 95% confidence interval included.



Mean Teacher Ratings on Overall Engagement

| | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth |
|---|---|---|---|---|---|---|---|---|
| Control | 3.8 | 3.7 | 3.2 | 3.8 | 3.6 | 4.1 | 3.5 | 3.9 |
| Intervention | 4.0 | 4.1 | 3.8 | 3.8 | 3.9 | 4.1 | 3.9 | 4.4 |

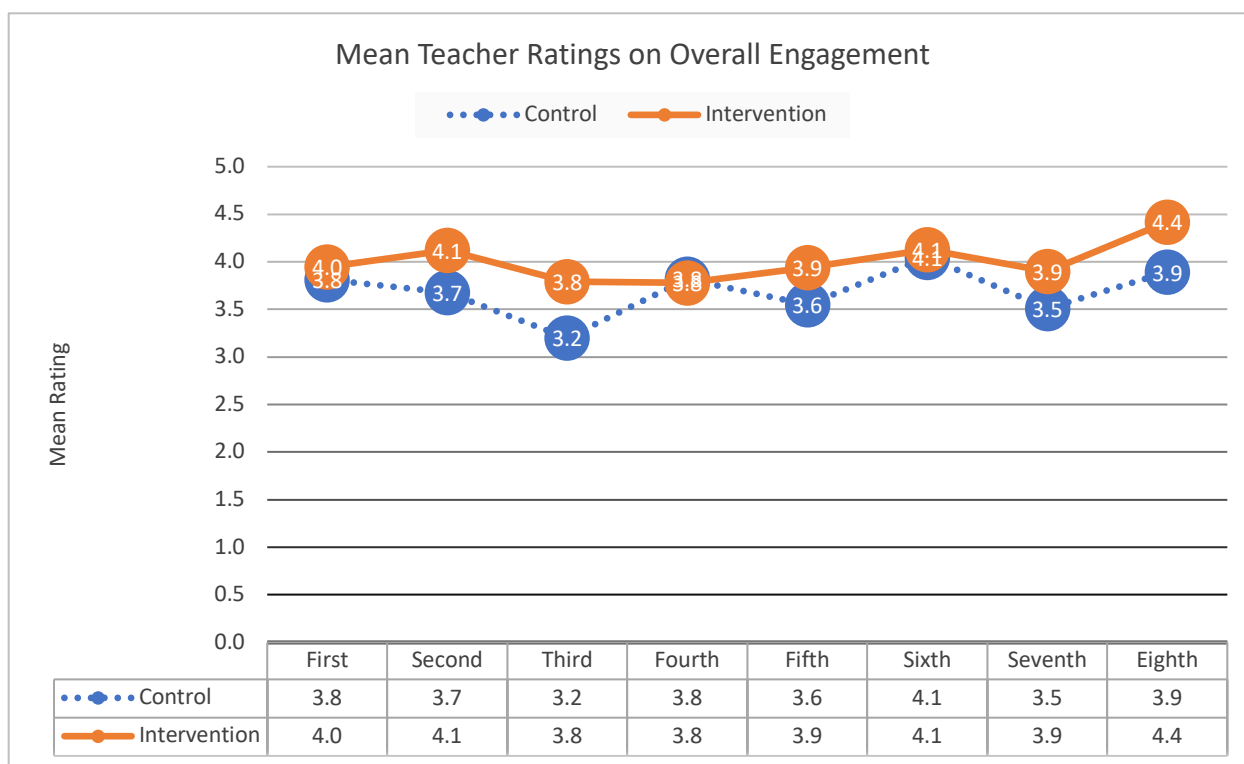*Figure 2.8.* Mean teacher ratings on overall engagement.

**Section III**

**Teacher Survey Results: Spring 2018**

**Teacher Demographics**

A survey was administered in spring 2018 to teachers who were using chess with their

students as part of the Chess in Schools program. A total of 62 teachers responded to the survey.

Of the respondents, 74% ($n = 46$) identified as female and 22% ($n = 14$) identified as 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 3.1 shows the distribution of respondents by grade level
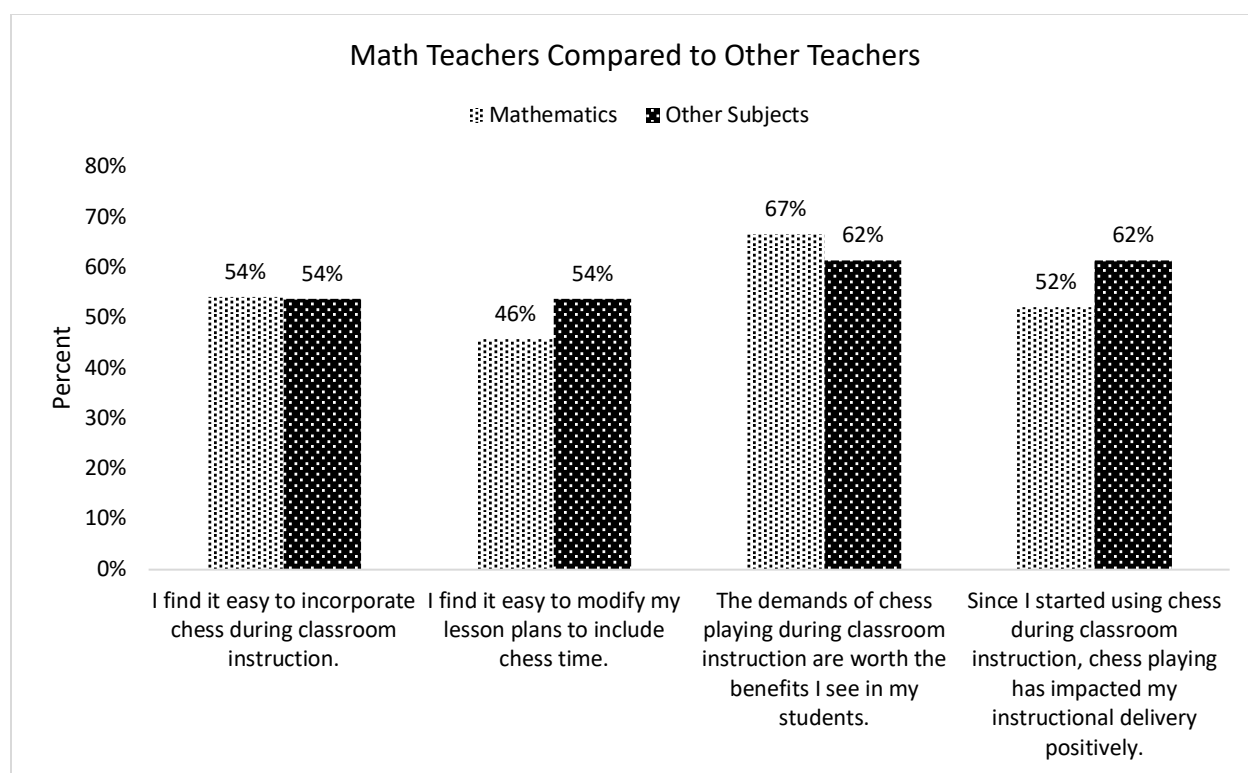
taught.

Table 3.1. Percent Distribution of Respondents by Grade Level Taught

| Grade | Percent of Teacher Respondents |
|-------|-------------------------------|
| 2 | 16% |
| 3 | 13% |
| 4 | 16% |
| 5 | 20% |
| 6 | 13% |
| 7 | 7% |
| 8 | 6 % |
| Other | 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 mathematics instruction, all other categories were combined in order to make a comparison of mathematics to all other subjects. Both groups showed similar perceptions of their ability to incorporate chess into their instruction or programs. These perceptions are presented in Figure 3.1.

## Math Teachers Compared to Other Teachers

⠿ Mathematics  ▨ Other Subjects

| | I find it easy to incorporate chess during classroom instruction. | I find it easy to modify my lesson plans to include chess time. | The demands of chess playing during classroom instruction are worth the benefits I see in my students. | Since I started using chess during classroom instruction, chess playing has impacted my instructional delivery positively. |
|---|---|---|---|---|
| Mathematics | 54% | 46% | 67% | 52% |
| Other Subjects | 54% | 54% | 62% | 62% |

*Figure 3.1.* Teacher Perceptions About Incorporating Chess in Instruction

Equal percentages (54%) of mathematics 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.

Answering an open-ended question, teachers who used chess during classroom instruction reported they struggled to find adequate time and that feelings of stress influenced their method(s) of lesson delivery. Despite these obstacles, 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 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 share their perceptions regarding the observed benefits of chess as an instructional strategy. Table 3.2 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 3.2. Perceived Benefits of Chess by Teachers Since they Started Using Chess

| Since I started teaching with chess… | Percent | *n* |
|---|---|---|
| My students are better at problem solving | 78% | 46 |
| My students are getting better at strategic thinking | 75% | 44 |
| My students are better at thinking critically | 73% | 43 |
| My students are better at decision making | 64% | 37 |
| My students are more interested in school | 62% | 36 |
| My students are more engaged in class | 59% | 35 |
| My students are better at socializing | 59% | 35 |
| My students participate more in class | 58% | 34 |
| My students' retention of complex or difficult concepts is improving | 58% | 34 |
| My students are more interested in the subject/discipline | 56% | 33 |
| My students' academic achievement has improved | 49% | 29 |
| My students are better at time management | 48% | 28 |
| My students are putting more effort in their work | 47% | 27 |
| My students are better at organization | 41% | 24 |
| My students are more interested in schoolwork | 37% | 22 |

Of the 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%); students getting

better at organizing (41%) 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 by 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 3.2.
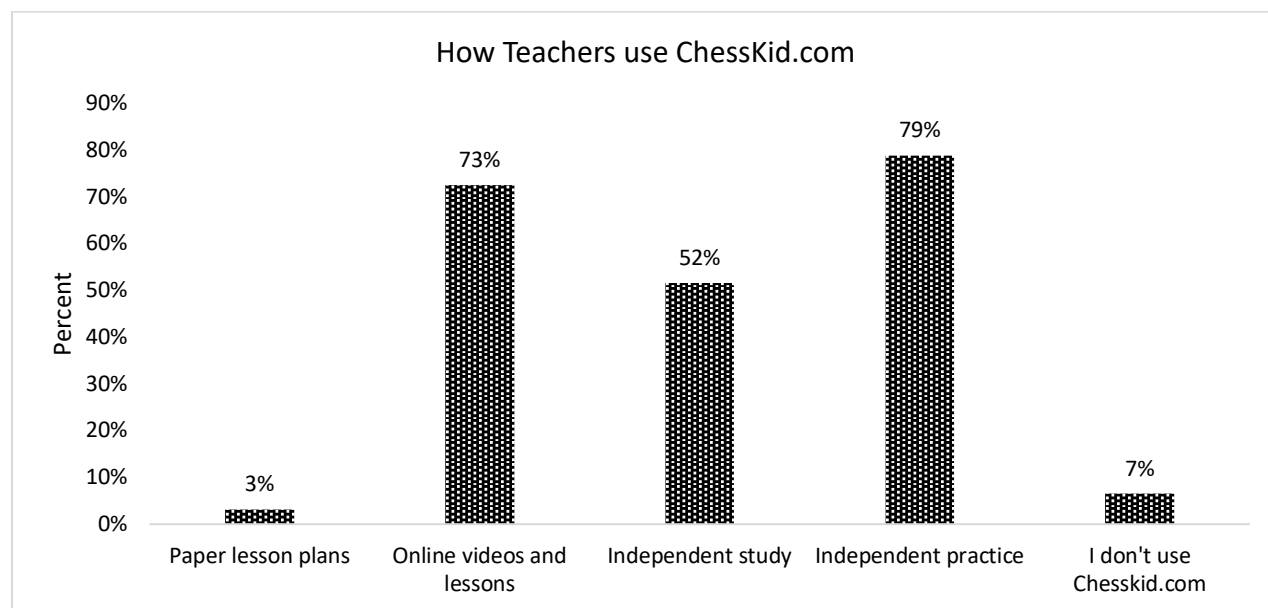


*Figure 3.2.* How Teachers use ChessKid.com

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 exposing students to chess at an earlier 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. Improved 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 perceived large gains in the students' abilities across a variety of cognitive and social abilities (Table 3.2). 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 approach for teachers to implement chess into their lessons, with only a small number of teachers (7%) indicating a preference for not utilizing the website (Figure 3.2). Overall, these factors

indicate chess as an instructional strategy provided a positive and meaningful educational

experience for students and teachers.

**Section IV**

**Student Survey Results: Spring 2018**

**Student Demographics**

A survey was administered in spring 2018 to students in Alabama schools who participated in the Chess in Schools initiative. A total of 1,286 students in grades 1-12 completed the survey. Although the program involved mostly teachers in grades 1-10, there were a few 11th and 12th grade teachers who also volunteered to take part. These 11 teachers are included in this section of the report addressing the student survey. Two equivalent forms of the instrument were administered, one suitable for younger students in grades 1-4 (with emojis rather than numerical values and descriptions for response choices), and the other for students in grades 5-12.

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 4.1. Findings are reported for the two broad groupings of grades rather than by each grade level. We did not seek to draw comparisons between the two grade level groups.

Table 4.1. Distribution of Students by Grade Level

| Grade Level | Grade | Frequency | Percent |
|---|---|---|---|
| 1-4 | 1 | 36 | 8% |
| | 2 | 181 | 38% |
| | 3 | 97 | 20% |
| | 4 | 169 | 35% |
| | **Total** | **483** | **100%** |
| 5-12 | 5 | 240 | 30% |
| | 6 | 153 | 19% |
| | 7 | 139 | 17% |
| | 8 | 78 | 10% |
| | 9 | 76 | 10% |
| | 10 | 106 | 13% |
| | 11 | 7 | 1% |
| | 12 | 4 | 1% |
| | **Total** | **803** | **100%** |

The gender distribution of students is presented in Table 4.2. The proportion of males to females was almost identical for grades 1-4. In grades 5-12 there were slightly more males (54%) than females (46%).

Table 4.2. Gender Distribution of Students by Grade Level

| Grade Level | Gender | Frequency | Percent |
|---|---|---|---|
| | Female | 237 | 49% |
| 1-4 | Male | 246 | 51% |
| | Total | 483 | 100% |
| | Female | 368 | 46% |
| 5-12 | Male | 435 | 54% |
| | Total | 803 | 100% |

There were no gender differences in reporting the perceived benefits of chess. Both male and female students reported similar perceived benefits of chess playing.

**Use of ChessKid.com**

More students reported practicing chess via ChessKid.com in grades 5-12 (82%) than in grades 1-4 (67%), as displayed in Table 4.3. For the students who reported that their teacher used chess during instruction, 75% of students in grades 1-4 and 86% of students in grades 5-12 said they practiced via ChessKid.com.

Table 4.3. I Practice Chess on ChessKid.com

| Grade Level | Teacher does not use chess during instruction | Teacher uses chess during instruction | Total |
|---|---|---|---|
| 1-4 | 54% ($n = 98$) | 75% ($n = 222$) | 67% ($n = 320$) |
| 5-12 | 60% ($n = 68$) | 86% ($n = 590$) | 82% ($n = 658$) |

Overall, 40% 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 4.4).

And, 60% of students in grades 1-4 and 66% of students in grades 5-12 reported using

ChessKid.com to practice or play chess at school other than during chess class, at least

sometimes.

Table 4.4. 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 |
|---|---|---|---|
| 1-4 | Not at all | 58% ($n = 281$) | 39% ($n = 186$) |
| | Sometimes | 28% ($n = 137$) | 34% ($n = 164$) |
| | Many times | 12% ($n = 60$) | 26% ($n = 123$) |
| | Total | 100% ($n = 478$) | 100% ($n = 473$) |
| 5-12 | Not at all | 60% ($n = 479$) | 33% ($n = 265$) |
| | Sometimes | 31% ($n = 248$) | 45% ($n = 359$) |
| | Many times | 8% ($n = 66$) | 21% ($n = 169$) |
| | Total | 100% ($n = 793$) | 100% ($n = 793$) |

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

In grades 1-4, 34% ($n = 166$) of the students participated in chess clubs, and in grades 5-

12, 32% ($n = 253$) participated in chess clubs. Table 4.5 shows the percentage distribution of

students' responses regarding how often they played chess outside of school and at home.

Overall, 30% of students in grades 1-4 and 37% 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 (54%) reported playing chess at home than those in grades 5-12 (45%).

Table 4.5. 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 |
|---|---|---|---|
| 1-4 | Not at all | 69% ($n = 331$) | 44% ($n = 214$) |
| | Sometimes | 26% ($n = 125$) | 41% ($n = 199$) |
| | Many times | 4% ($n = 21$) | 13% ($n = 65$) |
| | Total | 100% ($n = 477$) | 100% ($n = 478$) |
| 5-12 | Not at all | 61% ($n = 491$) | 53% ($n = 427$) |
| | Sometimes | 33% ($n = 269$) | 36% ($n = 293$) |
| | Many times | 4% ($n = 33$) | 9% ($n = 74$) |
| | Total | 100% ($n = 793$) | 100% ($n = 794$) |

**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 (See Table 4.6). 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 levels indicated that chess provided entertainment, a detail that may be important to foster student engagement.

Table 4.6. Students' Perceptions about Ability to Play Chess, by Grade Level

| Perceptions | Grades 1-4 | Grades 5-12 |
|---|---|---|
| Anyone can learn chess. | 78% (n = 355) | 70% ($n = 549$) |
| Chess is a fun game. | 84% ($n = 398$) | 64% ($n = 508$) |
| Chess is something I am good at. | 71% ($n = 327$) | 49% ($n = 385$) |
| Chess provides entertainment. | 79% ($n = 375$) | 60% ($n = 479$) |
| I am confident in my ability to play chess. | 77% ($n = 346$) | 56% ($n = 439$) |
| I enjoy playing chess. | 82% ($n = 392$) | 64% ($n = 514$) |
| I enjoy playing chess with my classmates. | 83% ($n = 393$) | 72% ($n = 572$) |
| I find chess confusing. | 40% ($n = 185$) | 26% ($n = 209$) |
| I put a lot of effort into my schoolwork. | 90% ($n = 426$) | 82% ($n = 651$) |
| My teachers make learning exciting. | 82% ($n = 384$) | 62% ($n = 494$) |
| When I am doing my schoolwork, I get very engaged. | 71% ($n = 329$) | 59% ($n = 471$) |

Table 4.7 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 benefits based on students' rankings were: I work harder on assignments

(82%); I can now do the hardest work if I try (80%); I work better with my teachers at school

(77%); I feel more successful at school (77%); and My grades have improved (76%). It is worth

noting that a majority of the students indicated that all benefits listed in Table 4.7 had occurred.

Generally, the percentages of females tended to be higher than males across most items.

Table 4.7. Perceived Benefits of Chess Grades 1-4 (Ordered by Rank)

| Since I started learning with chess… | Female | Male | Total |
|---|---|---|---|
| I work harder on my school work. | 84% ($n$ = 196) | 80% ($n$ = 191) | 82% ($n$ = 387) |
| I can now do the hardest work if I try. | 82% ($n$ = 187) | 79% ($n$ = 183) | 80% ($n$ = 370) |
| I work better with my teachers at school. | 83% ($n$ = 191) | 72% ($n$ = 172) | 77% ($n$ = 363) |
| I feel more successful at school. | 78% ($n$ = 175) | 76% ($n$ = 178) | 77% ($n$ = 353) |
| My grades have improved. | 80% ($n$ = 180) | 72% ($n$ = 166) | 76% ($n$ = 346) |
| I am more excited about learning. | 78% ($n$ = 180) | 73% ($n$ = 174) | 76% ($n$ = 354) |
| I participate more in class. | 74% ($n$ = 170) | 75% ($n$ = 179) | 74% ($n$ = 349) |
| I can organize my life better. | 74% ($n$ = 167) | 71% ($n$ = 169) | 73% ($n$ = 336) |
| I work better with other students at school. | 73% ($n$ = 162) | 69% ($n$ = 163) | 71% ($n$ = 325) |
| I can organize my schoolwork better. | 68% ($n$ = 156) | 69% ($n$ = 167) | 69% ($n$ = 323) |
| I am better at managing time. | 68% ($n$ = 155) | 66% ($n$ = 158) | 67% ($n$ = 313) |
| I am more interested in school. | 71% ($n$ = 166) | 63% ($n$ = 151) | 67% ($n$ = 317) |
| I spend more time working with my classmates. | 70% ($n$ = 166) | 63% ($n$ = 153) | 67% ($n$ = 319) |
| I enjoy mathematics more. | 67% ($n$ = 156) | 64% ($n$ = 150) | 65% ($n$ = 306) |
| I am more interested in mathematics. | 65% ($n$ = 149) | 61% ($n$ = 145) | 63% ($n$ = 294) |

As shown in Table 4.8, the five highest ranked benefits by students in grades 5-12 were: I

can now do the hardest work if I try (65%); I work harder on my school work (65%); I feel more

successful at school (64%); My grades have improved (59%); and I work better with my teachers

at school (56%). Items that scored the lowest were: I enjoy mathematics more (43%), I am more

interested in mathematics (41%), and I spend more time working with my classmates (41%).

Similar to students in grades 1-4, the percentages of females tended to be higher than males for

most of the items.

Table 4.8. Perceived Benefits of Chess Grades 5-12 (Ordered by Rank)

| Since I started learning with chess… | Female | Male | Total |
|---|---|---|---|
| I can now do the hardest work if I try. | 67% (*n* = 242) | 64% (*n* = 270) | 65% (*n* = 512) |
| I work harder on my school work. | 69% (*n* = 248) | 62% (*n* = 263) | 65% (*n* = 511) |
| I feel more successful at school. | 64% (*n* = 231) | 65% (*n* = 272) | 64% (*n* = 503) |
| My grades have improved. | 59% (*n* = 216) | 59% (*n* = 254) | 59% (*n* = 470) |
| I work better with my teachers at school. | 58% (*n* = 210) | 54% (*n* = 228) | 56% (*n* = 438) |
| I can organize my life better. | 56% (*n* = 204) | 55% (*n* = 236) | 55% (*n* = 440) |
| I participate more in class. | 57% (*n* = 209) | 52% (*n* = 227) | 54% (*n* = 436) |
| I can organize my schoolwork better. | 57% (*n* = 210) | 51% (*n* = 222) | 54% (*n* = 432) |
| I work better with other students at school. | 51% (*n* = 188) | 54% (*n* = 235) | 53% (*n* = 423) |
| I am better at managing time. | 51% (*n* = 186) | 49% (*n* = 211) | 50% (*n* = 397) |
| I am more excited about learning. | 50% (*n* = 182) | 47% (*n* = 201) | 49% (*n* = 383) |
| I am more interested in school. | 52% (*n* = 192) | 43% (*n* = 188) | 47% (*n* = 380) |
| I enjoy mathematics more. | 45% (*n* = 164) | 42% (*n* = 183) | 43% (*n* = 347) |
| I am more interested in mathematics. | 41% (*n* = 151) | 42% (*n* = 181) | 41% (*n* = 332) |
| I spend more time working with my classmates. | 44% (*n* = 160) | 39% (*n* = 171) | 41% (*n* = 331) |

**Summary of Findings Related to Students' Perceptions**

The findings in this section of the report point to a similar trend across all grade levels as well as between genders. Of the 1,286 chess-playing student respondents, not only did they enjoy playing chess at school, but many of them also reported playing outside of class time or outside of school. A majority of the students expressed a positive view of their abilities to play the game. Both grade level groups indicated 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 working harder on school work.

# Appendices

**Appendix 1A**

Induction Score Summary Statistics by Grade and Group

| Grade | Group | Year 1 Mean | Year 1 Std. Error | Year 2 Mean | Year 2 Std. Error | Year 3 Mean | Year 3 Std. Error | Total Mean | Total Std. Error |
|---|---|---|---|---|---|---|---|---|---|
| 4 | Control | 12.8 | .58 | 10.4 | .62 | 11.8 | .60 | 11.7 | .34 |
| | Intervention | 13.4 | .37 | 11.3 | .40 | 12.1 | .29 | 12.3 | .20 |
| 5 | Control | 13.9 | .80 | 13.4 | .74 | 12.4 | .59 | 12.9 | .39 |
| | Intervention | 14.0 | .54 | 12.9 | .28 | 13.3 | .29 | 13.3 | .19 |
| 6 | Control | 13.0 | .83 | 11.4 | .95 | 12.0 | .46 | 12.2 | .39 |
| | Intervention | 15.6 | .58 | 11.0 | .49 | 11.3 | .34 | 12.3 | .27 |
| 7 | Control | 16.2 | .87 | 11.6 | .84 | 12.6 | 1.02 | 13.7 | .51 |
| | Intervention | 13.1 | .90 | 10.6 | .79 | 12.8 | .32 | 12.6 | .29 |
| 8 | Control | 13.3 | .90 | 12.5 | .71 | 16.7 | 2.84 | 13.1 | .61 |
| | Intervention | 13.3 | .47 | 13.1 | .68 | 11.8 | 1.27 | 13.0 | .39 |
| 9 | Control | - | - | 13.1 | .65 | - | - | 13.2 | .64 |
| | Intervention | - | - | 14.3 | .78 | - | - | 14.3 | .55 |
| 10 | Control | - | - | 14.5 | .88 | 14.9 | 2.40 | 14.6 | .88 |
| | Intervention | - | - | 12.8 | .64 | 10.7 | .79 | 11.8 | .51 |

For the construct induction:

- The intervention group score means were higher than the control group in grades 4, 5, and 6, in Year 1; grades 4, 8, and 9 in Year 2; and grades 4, 5, and 7 in Year 3.

- The intervention group score means were slightly lower than the control group for grade 7 in Year 1; grades 5, 6, 7, and 10 in Year 2; and grades 6, 8, and 10 in Year 3.

**Appendix 1B**

Observation and Credibility Score Summary Statistics by Grade and Group

| Grade | Group | Year 1 | | Year 2 | | Year 3 | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error |
| 4 | Control | 9.3 | .49 | 9.4 | .43 | 10.1 | .53 | 9.6 | .28 |
| | Intervention | 10.1 | .31 | 9.3 | .30 | 9.9 | .25 | 9.8 | .17 |
| 5 | Control | 10.1 | .52 | 10.1 | .63 | 9.7 | .51 | 9.8 | .33 |
| | Intervention | 11.0 | .36 | 10.3 | .24 | 10.7 | .26 | 10.6 | .16 |
| 6 | Control | 8.6 | .68 | 9.4 | 1.06 | 10.4 | .39 | 9.9 | .33 |
| | Intervention | 10.8 | .47 | 9.7 | .54 | 8.9 | .30 | 9.5 | .23 |
| 7 | Control | 11.0 | .67 | 9.3 | .64 | 11.9 | .93 | 10.6 | .45 |
| | Intervention | 9.7 | .69 | 9.0 | .61 | 10.4 | .30 | 10.1 | .25 |
| 8 | Control | 10.8 | .90 | 9.5 | .61 | 6.0 | 2.04 | 9.8 | .54 |
| | Intervention | 10.4 | .47 | 10.1 | .58 | 11.5 | .91 | 10.5 | .35 |
| 9 | Control | - | - | 10.1 | .50 | - | - | 10.2 | .55 |
| | Intervention | - | - | 12.2 | .60 | - | - | 11.9 | .47 |
| 10 | Control | - | - | 10.1 | .98 | 10.2 | 1.77 | 10.2 | .80 |
| | Intervention | - | - | 10.9 | .71 | 11.5 | .62 | 11.2 | .46 |

For the constructs of observation and credibility:

- The intervention group score means were higher than the control group for grades 4, 5, and 6 in Year 1; grades 5, 6, 8, 9, and 10 in Year 2; and grades 5, 8, and 10 in Year 3.

- The intervention group score means were lower than the control group for grades 7 and 8 in Year 1; grades 4 and 7 in Year 2; and grades 4, 6, and 7 in Year 3. There were no data for grade 9 in Years 1 and 3.

**Appendix 1C**

Deduction Score Summary Statistics by Grade and Group

| Grade | Group | Year 1 Mean | Year 1 Std. Error | Year 2 Mean | Year 2 Std. Error | Year 3 Mean | Year 3 Std. Error | Total Mean | Total Std. Error |
|---|---|---|---|---|---|---|---|---|---|
| 4 | Control | 8.9 | .53 | 5.9 | .49 | 6.4 | .52 | 7.1 | .31 |
| | Intervention | 10.7 | .33 | 6.7 | .34 | 6.9 | .25 | 8.0 | .18 |
| 5 | Control | 11.8 | .64 | 8.7 | .62 | 6.9 | .48 | 8.4 | .33 |
| | Intervention | 12.5 | .44 | 7.7 | .24 | 7.6 | .26 | 8.4 | .17 |
| 6 | Control | 10.4 | .75 | 5.0 | .77 | 6.5 | .39 | 7.4 | .34 |
| | Intervention | 11.3 | .51 | 6.2 | .40 | 5.8 | .32 | 7.4 | .25 |
| 7 | Control | 10.4 | .62 | 6.6 | .48 | 6.9 | .76 | 8.0 | .38 |
| | Intervention | 9.9 | .64 | 5.6 | .47 | 7.4 | .25 | 7.6 | .22 |
| 8 | Control | 11.7 | .90 | 6.6 | .59 | 8.8 | 3.40 | 9.1 | .56 |
| | Intervention | 10.6 | .48 | 7.6 | .58 | 6.4 | .91 | 9.1 | .36 |
| 9 | Control | - | - | 8.4 | .86 | - | - | 8.4 | .84 |
| | Intervention | - | - | 8.1 | .98 | 8.0 | 1.01 | 8.0 | .66 |
| 10 | Control | - | - | 8.8 | 1.92 | 12.4 | 1.72 | 10.3 | 1.34 |
| | Intervention | - | - | 9.2 | .84 | 7.5 | .62 | 8.4 | .54 |

For the construct deduction:

- The intervention group score means were higher than the control group for grades 4, 5, and 6 in Year 1; grades 4, 6, 8, and 10 in Year 2; and grades 4, 5, and 7 in Year 3.

- The intervention group score means were lower than the control group for grades 7 and 8 in Year 1; grades 5, 7, and 9 in Year 2; and grades 6, 8, and 10 in Year 3.

**Appendix 1D**

Assumptions Score Summary Statistics by Grade and Group

| Grade | Group | Year 1 | | Year 2 | | Year 3 | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error |
| 4 | Control | 3.4 | .40 | 2.9 | .27 | 3.2 | .28 | 3.2 | .18 |
| | Intervention | 3.5 | .19 | 3.4 | .20 | 3.5 | .14 | 3.5 | .10 |
| 5 | Control | 3.3 | .34 | 3.7 | .39 | 3.5 | .27 | 3.5 | .19 |
| | Intervention | 3.6 | .24 | 3.7 | .14 | 3.8 | .15 | 3.7 | .09 |
| 6 | Control | 3.2 | .43 | 3.4 | .54 | 3.8 | .28 | 3.5 | .22 |
| | Intervention | 3.9 | .29 | 3.7 | .28 | 3.4 | .25 | 3.6 | .16 |
| 7 | Control | 4.3 | .39 | 2.5 | .39 | 3.8 | .58 | 3.5 | .27 |
| | Intervention | 3.5 | .39 | 4.1 | .37 | 3.5 | .18 | 3.6 | .15 |
| 8 | Control | 3.0 | .48 | 3.4 | .36 | 1.4 | 1.42 | 3.1 | .30 |
| | Intervention | 3.3 | .25 | 3.7 | .34 | 4.5 | .44 | 3.6 | .19 |
| 9 | Control | - | - | 4.4 | .64 | - | - | 4.5 | .55 |
| | Intervention | - | - | 3.9 | .83 | - | - | 3.5 | .44 |
| 10 | Control | - | - | 2.9 | 1.33 | 5.9 | 1.37 | 5.0 | 1.10 |
| | Intervention | - | - | 5.9 | .50 | 4.4 | .52 | 4.9 | .42 |

For the construct assumptions:

- The intervention group score means were higher than the control group for grades 4, 5, 6, and 8 in Year 1; grades 4, 6, 7, 8, and 10 in Year 2; and grades 4, 5, and 8 in Year 3.

- The intervention group score means were lower than the control group for grade 7 in Year 1; grade 9 in Year 2; and grades 6, 7, and 10 in Year 3. There seemed to be no difference for grade 5 in Year 2. No comparisons were possible for grade 9 in Year 3.

**Appendix 1E**

Overall Posttest Score Summary Statistics by Grade and Group

| Grade | Group | Year 1 Mean | Year 1 Std. Error | Year 2 Mean | Year 2 Std. Error | Year 3 Mean | Year 3 Std. Error | Total Mean | Total Std. Error |
|---|---|---|---|---|---|---|---|---|---|
| 4 | Control | 30.1 | 1.23 | 27.7 | 1.33 | 31.9 | 1.28 | 30.0 | .74 |
| 4 | Intervention | 33.0 | .78 | 30.7 | .88 | 31.8 | .62 | 31.9 | .43 |
| 5 | Control | 34.8 | 1.24 | 33.6 | 1.50 | 31.3 | 1.35 | 32.5 | .84 |
| 5 | Intervention | 37.1 | .85 | 34.6 | .58 | 35.4 | .66 | 35.4 | .41 |
| 6 | Control | 32.0 | 1.45 | 29.8 | 2.19 | 32.0 | 1.01 | 31.6 | .78 |
| 6 | Intervention | 36.5 | 1.00 | 30.4 | 1.13 | 28.2 | .75 | 30.9 | .54 |
| 7 | Control | 37.2 | 1.59 | 29.9 | 1.32 | 35.2 | 1.97 | 34.4 | .95 |
| 7 | Intervention | 32.9 | 1.64 | 29.2 | 1.25 | 33.7 | .63 | 33.0 | .53 |
| 8 | Control | 34.9 | 2.08 | 31.5 | 1.20 | 25.0 | 5.05 | 32.4 | 1.24 |
| 8 | Intervention | 33.0 | 1.09 | 34.9 | 1.14 | 32.3 | 2.25 | 33.3 | .79 |
| 9 | Control | - | - | 33.7 | 1.77 | - | - | 34.2 | 1.76 |
| 9 | Intervention | - | - | 34.2 | 2.14 | 37.6 | 2.18 | 35.4 | 1.51 |
| 10 | Control | - | - | 29.4 | 2.26 | 40.6 | 4.77 | 32.2 | 2.05 |
| 10 | Intervention | - | - | 34.8 | 1.65 | 33.3 | 1.62 | 33.8 | 1.18 |

Overall posttest scores in the intervention group were higher for grades 4, 5, and 6 in Year 1; grades 4, 5, 6, 8, 9, and 10 in Year 2; and grades 5 and 8 in Year 3. The intervention group scored lower than the control for grades 7 and 8 in Year 1; grade 7 in Year 2; and grades 4, 6, 7, and 10 in Year 3. The general trend thus points towards the intervention group having higher mean performance than the control group.

**Appendix 2A**

Distribution of Students by Year and Group for the 21st Century Skills Assessment

| Grade | Year 1 | | Year 2 | | Year 3 | | Year 4 | |
|---|---|---|---|---|---|---|---|---|
| | Control | Intervention | Control | Intervention | Control | Intervention | Control | Intervention |
| 1 | 22 (31%) | 47 (68%) | 19 (48.7) | 20 (51%) | - | - | - | - |
| 2 | - | - | 19 (48%) | 20 (51%) | 18 (43%) | 23 (56%) | - | - |
| 3 | - | - | - | - | 32 (31%) | 71 (68%) | 37 (26%) | 105 (73%) |
| 4 | 49 (23%) | 158 (76%) | 117 (81%) | 26 (18%) | 31 (17%) | 146 (82%) | 20 (48%) | 21 (51%) |
| 5 | 41 (26%) | 113 (73%) | 38 (18%) | 171 (81%) | 53 (20%) | 209 (79%) | 26 (41%) | 37 (58%) |
| 6 | - | - | 37 (35%) | 67 (64%) | 50 (18%) | 227 (81%) | - | - |
| 7 | - | - | 23 (36%) | 40 (63%) | - | - | - | - |
| 8 | - | - | 21 (50%) | 21 (50%) | - | - | - | - |
| Total | 112 (26%) | 318 (74%) | 255 (42%) | 345 (57%) | 184 (21%) | 676 (78%) | 83 (33%) | 163 (66%) |

Control group data were not available for grades 2, 3, and 6 in Year 1 or for grades 7 and 8 in Year 3, thus comparisons were not possible.