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Students' perceived benefits of chess: Differences across age and gender

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Abstract

The purpose of this study was to determine differences in students' perceived benefits of chess by gender and age after being exposed to chess during instruction for an entire academic year as part of a Chess in Schools initiative in a southeastern state of the United States. Data were collected during the 2017–2018 academic year. The sample consisted of 1,286 students across elementary, middle, and high school levels. Data were collected using a retrospective pretest survey. Seven constructs of the students' perceptions were generated (*increased enjoyment of mathematics, improvement in academic self-efficacy, improvement in collaborative skills, improvement in organizational skills, enjoyment of chess, confidence in chess playing ability, and increased engagement in learning*), and all had high reliability coefficients. Data were analyzed using a two-way multivariate analysis of variance. The results showed that elementary students consistently tended to have higher ratings of perceived benefits than middle and high school students across all constructs. The differences between middle and high school students were low and not statistically significant.

Keywords

students' perceptions of chess, chess in school, cognitive impacts of chess, chess in education

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Students' Perceived Benefits of Chess: Differences Across Age and Gender

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Abstract

The purpose of this study was to determine differences in students' perceived benefits of chess by gender and age after being exposed to chess during instruction for an entire academic year as part of a Chess in Schools initiative in a southeastern state of the United States. Data were collected during the 2017–2018 academic year. The sample consisted of 1,286 students across elementary, middle, and high school levels. Data were collected using a retrospective pretest survey. Seven constructs of the students' perceptions were generated (*increased enjoyment of mathematics, improvement in academic self-efficacy, improvement in collaborative skills, improvement in organizational skills, enjoyment of chess, confidence in chess playing ability, and increased engagement in learning*), and all had high reliability coefficients. Data were analyzed using a two-way multivariate analysis of variance. The results showed that elementary students consistently tended to have higher ratings of perceived benefits than middle and high school students across all constructs. The differences between middle and high school students were low and not statistically significant.

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Introduction

Past studies have indicated various cognitive and non-cognitive benefits of chess among children and adults. Skills learned through chess have been found to transfer to domains such as socio-affective development, memory and creativity, visuo-spatial abilities, problem-solving abilities, and even reductions in risk-aversion (Aciego et al., 2012; Gliga & Flesner, 2013; Gobet & Campitelli, 2006; Islam et al., 2019; Kazemi et al., 2012). Not only has chess been associated with increased intelligence and academic performance, but its characteristics as a cognitively demanding game have also made it of high interest in educational spheres and media platforms as a strategy for improving various school outcomes (Jerrim et al., 2018).

Skills acquired through learning and playing chess can be carried over into other educational and social domains (Gobet & Campitelli, 2006). The chess player must strategically create a game plan while tactically choosing the most advantageous methods for the next move, a process requiring cognitive skills and knowledge (Gobet, 2019). Thus, students who receive chess instruction may

experience improvements in their grades, their confidence in school, and their abilities to solve problems, among other things. Although research varies on whether cognitive skills gained from chess instruction can be attributed to the process of learning chess or the potential differing characteristics present in students who choose to play chess as compared to students who do not, the skills which chess may develop within children, such as strategic thinking and logical reasoning, mirror the skills needed for academic success (Jerrim et al., 2018).

Literature Review

Perceptions of Benefits of Chess

Many of the perceived benefits of chess emphasize cognitive benefits for students. For example, chess has often been linked to improved mathematical abilities, represented through both standardized scores and the rate at which students learn new equations, solve problems, or memorize certain concepts. Kazemi et al. (2012) demonstrated the correlation between chess and mathematical ability in their experimental study, which investigated how chess impacted the meta-cognitive abilities and problem-solving skills of primary- and secondary-level male students in Iran. Compared with a control group of non-chess playing youth, those who played chess scored significantly higher on their meta-cognitive abilities and showed higher problem-solving skills in math. The correlations between chess and mathematical abilities may be related to the comparable way in which both activities rely on certain *moves* or problem-solving skills for success. Despite the similar cognitive functions needed in both chess and math, chess instruction was surprisingly not found to be correlated with an increase in memory skills for novice chess-playing students (Gliga & Flesner, 2013). Conversely, Jerrim et al.'s (2018) study indicated no correlation between chess playing and mathematical abilities, nor within reading or science capabilities of the students. According to Jerrim et al. (2018), most studies (specifically, those which found positive effects of chess on said outcomes) have not employed rigorous methods in terms of their research design and statistical analyses.

Despite controversy on the most rigorous study design for research specific to chess instruction in schools, many researchers have found significant relationships between chess instruction and cognitive benefits in other academic domains, even apart from math. Sala and Gobet (2016), for example, presented meta-analysis findings of an overall positive effect size of .34 across 24 smaller-scale, educational chess instruction studies regarding the intervention's correlation with student academic attainment. This not only points towards the growing popularity of using chess instruction as an educational tool, but also towards the overall prominence of such significantly positive, academic correlations of chess within other domains across current and past literature. This research further emphasized the importance of utilizing chess instruction for the various cognitive benefits gained by students across academic domains. Positive perceptions of teachers regarding the cognitive and non-cognitive impacts of chess on their students across different domains have also been found. Jerrim et al. (2016) evaluated a *Chess in Primary Schools* program which used chess instruction to potentially increase concentration, confidence, and strategic thinking ability of children aged 9 through 10. The researchers used process evaluation to determine that although students appreciated learning new skills and the theory of chess, their dislike of strict game rules was difficult for the chess tutors to manage during instruction. Jerrim et al. (2016) also found that some teachers perceived the impact of chess instruction to be particularly positive for lower achieving students, and many teachers planned to continue

incorporating chess into their future classes. Hovhannisyan et al. (2022) found that female teachers were more likely to perceive chess as an important way for children to develop intellectual skills than male teachers. However, these findings indicated that teacher-perceived benefits of chess instruction are positive, despite some of the hindrances of student contempt with the rules of the game. In addition to the perceived benefits of chess within academia, chess playing has also been found to correlate with non-cognitive domains outside of academia. One of the most notable non-cognitive outcomes associated with chess use in instruction outside of academia is reduction in risk-aversion. Islam et al. (2019) observed reduction in risk-aversion for students even one year after a chess intervention. This association between risk-aversion and chess could be attributed to the relationship between children's cognitive abilities and their subsequent risk preferences. Such a relationship implies another potential benefit of chess instruction for students in their continued development outside of academic pursuits.

Students' Perceived Benefits of Chess

In addition to the general perceptions of the cognitive and non-cognitive benefits of chess instruction, several studies have also examined how students perceive these benefits because of chess instruction. For example, Aciego et al. (2012) found students who played chess as an extracurricular activity self-perceived greater cognitive improvement in their academic adjustment than students who participated in other extracurricular activities. Despite their self-awareness of improved academic adjustment, students did not perceive an improvement in their personal adjustments or coping capacities, which contrasted with the self-ratings of their teachers. Unlike Aciego et al.'s (2012) study, Salome (2019) found that former participants of middle school chess programs (aged 18–35) perceived benefits of their middle school chess program as having provided them with relationship-building skills, teamwork, confidence, and resilience. Hence, although social-affective improvements in competencies are a potential benefit of chess, students can only self-perceive these benefits at a certain age of maturity. Compared with other extracurricular activities, chess players have been found to perceive improvements in domains outside of academia, such as those requiring adequate social skills or competencies. For example, Aciego et al. (2012) found that when compared with students who played soccer or basketball as an extracurricular activity, those who chose to play chess experienced significant improvements in their cognitive, academic, social, and problem-solving capacities, indicating both cognitive and non-cognitive improvements from students' perspectives. In their innovative study where students engaged in self-directed activity goals during their holiday, Tam et al. (2023) found that students who played chess experienced improved attitudes towards homework and perceived that learning chess resulted in improvements within their observation and patience skills. Students who experienced improved literary skills, potentially from learning chess, were also found to experience increases in their creative capacities in one experimental study (Sala & Gobet, 2016). This increase in creative capacities could signify the existence of skills transfer from chess to other domains. If such a transfer of skills is possible, chess instruction could have even greater cognitive and non-cognitive benefits than currently recognized.

Similarly, Chitiyo et al. (2021a) conducted a study to ascertain the perceptions of students who were exposed to chess for at least one academic year. The authors found that students of all ages (Grades 1 through 12) generally had positive perceptions of the benefits of chess. Students were asked to indicate the level of improvement they experienced in their learning since they started playing chess at school. At least 15 items related to perceptions of the usefulness of chess were

assessed, and across all items, most students, both male and female, indicated improvement. Items included the concepts of student-perceived interest in schoolwork, engagement in learning, interest in mathematics, higher order thinking skills, and 21st century skills such as organization and time management. The findings further strengthened those of Aciego et al. (2012), which indicated chess instruction had potential cognitive, problem-solving, and socio-affective benefits. Chitiyo et al.'s (2021a) findings about student perceptions of increased improvements in interest and engagement also built on those of Rosholm et al. (2017), which asserted the impacts of chess instruction are maximally beneficial for students reporting greater unhappiness and increased boredom in the mathematics classroom at the onset of chess instruction. Thus, these studies reinforce the existence of student perceptions of both cognitive and non-cognitive benefits of chess.

Purpose of the Study and Program Description

The purpose of the current study was to examine the perceived benefits of chess from student perspectives. The students were exposed to instruction which included chess for at least one academic year as part of a *Chess in Schools (CIS)* initiative in a southeastern state of the United States. Data were collected during the 2017–2018 academic year. During the CIS program, public school teachers were trained to incorporate chess into their classroom teaching while addressing curriculum standards. The expectation was that using chess would lead to improved critical thinking skills as well as several 21st Century Skills. The teachers, who numbered between 60 and 75, were from schools across the state, taught different subject areas, and spanned from first through twelfth grade. All participating teachers received training on how to use chess through a four-day professional development during the summer preceding the 2017–2018 school year. During training, teachers were shown how to connect the game of chess to certain curricula spheres, including literacy, math, critical thinking, and life skills. For example, direct connections would be made between a specific math standard, the lesson or unit addressing that standard, and how certain aspects of the game of chess could be used to emphasize or reinforce the concept being taught. The same approach was used for all subject areas covered. To ensure treatment fidelity, during the training, all teachers received sample lesson plans they could adapt to suit their specific subject areas and classroom contexts. However, no formal measure of treatment fidelity was employed. Gaining an understanding of student perceptions would provide a more holistic understanding of the potential benefits of chess in addition to measured traits like academic achievement or higher order thinking skills.

Given the purpose of the study, these specific research questions were addressed:

- Are there differences among seven constructs of perceived benefits of chess between males and females?
- Are there differences among seven constructs of perceived benefits of chess between students of different grade levels (elementary, middle, and high school)?
- Are the differences in the constructs of perceived benefits of chess between males and females, if any, consistent across grade levels?

Methods

Instrumentation

Students were asked to complete a survey to assess their perceptions of the benefits of chess after they had participated in the game for an entire academic year either during class time, in an after-school activity, or a combination of both. The survey was developed by the researchers in consultation with the coordinators of CIS, the latter working directly with the teachers. The survey tool was developed based on the goals of the CIS program and from a thorough review of the literature. The process of tool development was iterative, with versions of the instrument shared multiple times among the different program stakeholders and with input from survey methods experts. There were two equivalent versions of the survey tool, one with emojis for response choices which was administered to younger children in Grades 1–4, and another for students in Grades 5–12, which had numerical values and descriptions for response choices.

Design and Sample

This study utilized a retrospective pretest-posttest design. The instrument assessed the pretest perceptions of the participants retrospectively. A retrospective pretest approach was used because it eliminated the possibility of response shift bias compared to a traditional pretest-posttest approach. Response shift bias happens when the participant's conceptualization of the measured construct changes over time because of the influence of the intervention (Drennan & Hyde, 2008). With the retrospective pretest approach, respondents provide their responses based on a fixed definition of a construct as opposed to when they must use two different definitions at two separate times. The sample consisted of 1,286 students in Grades 1 through 12. The distribution of students by Grade level and gender is shown in Table 1. On all key variables used in the analysis, there was no concerning pattern of missing cases. Additionally, with the large sample size, the minuscule percentages of missing cases (ranging between 3% and 7% on the generated constructs) had no impact on the results. All teachers who used the chess strategy were asked to request that their students respond to the anonymous survey. Due to Institutional Review Board requirements and to maintain anonymity of the survey, the researchers did not require information regarding which teachers extended the request to their students, and therefore, how many students responded in each of their classes. The response rate to the survey is, therefore, estimated to be approximately 70% of the population of students to whom the survey request was extended.

Table 1. Distribution of Students by Grade Level and Gender

Grade Levels	Grade	Female	Male	Total
Elementary	Grade 1	20	16	36
	Grade 2	90	91	181
	Grade 3	48	49	97
	Grade 4	79	90	169
	Grade 5	111	129	240
	Total	348	375	723
Middle	Grade 6	61	92	153
	Grade 7	74	65	139
	Grade 8	38	40	78
	Total	173	197	370
High	Grade 9	32	44	76
	Grade 10	47	59	106
	Grade 11	2	5	7
	Grade 12	3	1	4
	Total	84	109	193

Data Analysis

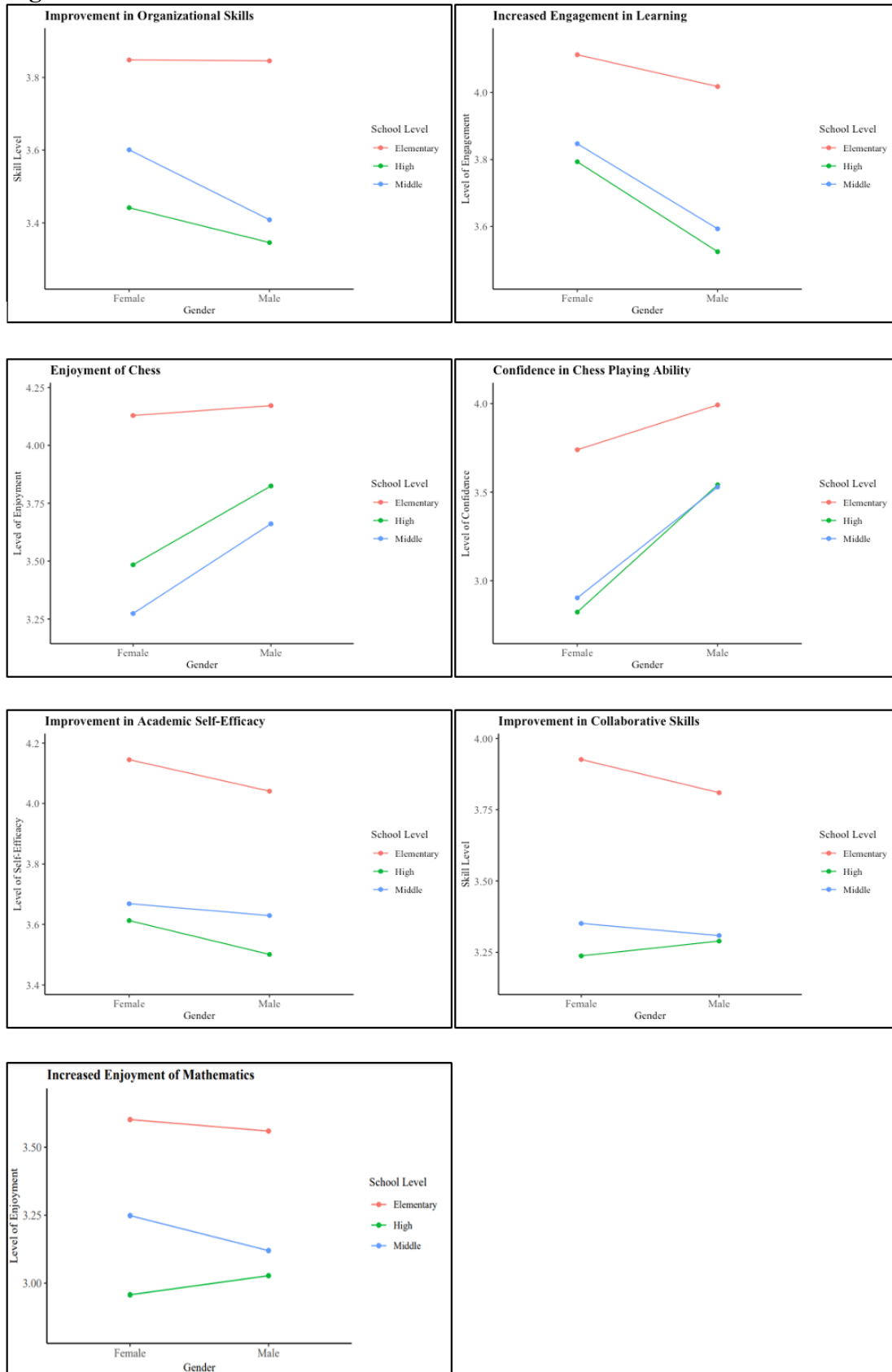
The first part of data analysis involved generating seven (7) constructs from 22 survey items that addressed the perceived benefits of chess. Survey items used to generate the constructs began with the statement, *since I began learning with chess . . .* The researchers grouped and combined the benefits of chess instruction into composite factors assessing similar beneficial aspects of chess instruction for use in subsequent analysis. The constructs generated included *increased enjoyment of mathematics, improvement in academic self-efficacy, improvement in collaborative skills, improvement in organizational skills, enjoyment of chess, confidence in chess playing ability, and increased engagement in learning*. Cronbach's alpha reliability coefficients were calculated for each of the constructs, and all were high (Fraenkel et al., 2019; Mohamad et al., 2015). Table 2 shows the reliability statistics for all the constructs and the items making up each of the constructs.

Table 2. Reliability Statistics for the Constructs of Perceived Benefits of Chess

Construct and Item	Cronbach's alpha
<i>Increased enjoyment of mathematics</i>	.895
I enjoy mathematics more	
I am more interested in mathematics	
<i>Improvement in academic self-efficacy</i>	.860
My grades have improved	
I work harder on my schoolwork	
I am more excited about learning	
I can now do the hardest work if I try	
I feel more successful at school	
<i>Improvement in collaborative skills</i>	.697
I spend more time working with my classmates	
I work better with other students at school	
I work better with my teachers at school	
<i>Improvement in organizational skills</i>	.813
I can organize my schoolwork better	
I can organize my life better	
I am better at managing my time	
<i>Enjoyment of chess</i>	.881
I enjoy playing chess	
I enjoy playing chess with my classmates	
Chess is a fun game	
Chess provides entertainment	
<i>Confidence in chess playing ability</i>	.749
Chess is something I am good at	
I am confident in my ability to play chess	
<i>Increased engagement in learning</i>	.651
I put a lot of effort into my schoolwork	
When I am doing schoolwork, I get very engaged	
I participate more in class	

To address the research questions about differences in each of the constructs by grade level and gender, a two-way multivariate analysis of variance (MANOVA) was conducted with the independent variables of gender and grade level. For this analysis, the three grade level groupings were elementary, middle, and high. A multivariate analysis approach was utilized because the analysis included multiple outcomes (Mertler et al., 2021). The differences in each of the constructs by both independent variables are plotted in Figure 1.

Figure 1. Plots of the Interaction Between Grade Level and Gender for all Constructs



Findings

After identifying the benefits of chess constructs, a two-way MANOVA was conducted to identify differences among the benefits of chess (*increased enjoyment of mathematics, improvement in academic self-efficacy, improvement in collaborative skills, improvement in organizational skills, enjoyment of chess, confidence in chess playing ability, and increased engagement in learning*) across gender (male or female) and grade level (elementary, middle, or high). Box's M test for homoscedasticity showed significance, [$F(140, 468,924) = 1.44, p < .001$], so Pillai's Trace was used to evaluate the significance of the multivariate model. The multivariate results showed that the main effect of grade level was significant [$Pillai's Trace = .139, F(14, 2096) = 11.17, p < .001, \eta_p^2 = .069$], as well as the main effect of gender [$Pillai's Trace = .082, F(7, 1047) = 13.28, p < .001, \eta_p^2 = .082$]. The interaction between grade level and gender was also statistically significant [$Pillai's Trace = .026, F(14, 2096) = 1.95, p = .018, \eta_p^2 = .013$]. The main effects of grade level and gender, as well as the interaction effect between grade level and gender, all have statistically significant effects on the variance among the benefits of chess constructs. Table 3 includes the results of the MANOVA.

Table 3. MANOVA Summary Results

Variable	df	Pillai's Trace	Num df	Den df	p
Grade Level	2	.137	14	2096	<.001
Gender	1	.074	7	1047	<.001
Grade Level* Gender	2	.026	14	2096	.018

The univariate tests of between subject effects indicated that the main effect of grade level was significant for each of the benefits of chess. The main effect of gender was significant for *enjoyment of chess* [$F(1, 1053) = 17.14, p = .000, \eta_p^2 = .016$], where males reported benefiting more than females in this regard; *confidence in chess playing ability* [$F(1, 1053) = 49.57, p = .000, \eta_p^2 = .045$], where males had higher ratings than females; and *increased engagement in learning* [$F(1, 1053) = 12.79, p = .000, \eta_p^2 = .012$], where females had higher ratings than males. The main effect of grade level was significant across all seven constructs, with elementary students having higher ratings on average than the other grade levels. Post-hoc tests using Tukey's HSD showed that elementary students had significantly higher means than middle and high school students across all constructs, but there was no significant difference between middle and high school students.

Figure 1 shows plots of the interaction between grade level and gender for each of the seven constructs. The pattern of differences was consistent with elementary students' ratings being higher than ratings for middle and high school students. The interaction effect of grade level and gender was also significant for *enjoyment of chess* [$F(2, 1053) = 3.47, p = .032, \eta_p^2 = .007$], and *confidence in chess playing abilities* [$F(2, 1053) = 3.73, p = .024, \eta_p^2 = .007$].

The following points summarize main findings by each construct:

- Regarding *improvement in organizational skills*, elementary students tended to have greater skill levels than middle or high school students. Additionally, at the middle and high school grade levels, females tended to have greater skill levels than males.
- *Increased engagement in learning* tended to be highest among elementary students, and females tended to have higher levels of engagement across all grade levels when compared to their male counterparts.

- Elementary students tended to have greater levels of *enjoyment of chess* than middle or high school students. Males tended to have greater levels of enjoyment across all grade levels as compared to females.
- *Confidence in chess playing ability* tended to be highest among elementary students as compared to middle or high school students. Additionally, males tended to have higher levels of confidence than their female counterparts across all grade levels. There was very little difference between females in middle and high school, and no difference between males at the same two grade levels.
- Pertaining to *improvement in academic self-efficacy*, elementary students reported improving the most compared to middle or high school students, and females tended to have a slightly greater level of self-efficacy than their male counterparts across all grade levels.
- For *improvement in collaborative skills*, females tended to have a greater level of collaborative skills as compared to males for elementary and middle school students, but males had a greater level of collaborative skills at the high school grade level. Like the pattern with the other constructs, elementary students reported improving most in their collaborative skills.
- With *improvement in organizational skills*, elementary students were at the top, with no apparent difference between males and females. With middle and high school students, females tended to have a slight edge over males. High school students reported the least gain on this construct.

Discussion and Conclusions

The benefits of chess playing have been well-documented throughout research (Aciego et al., 2012; Gobet & Campitelli, 2006; Gumede et al., 2017). This study sought to explore students' perceived benefits of chess and to examine how these benefits differ by gender and grade level. The results of this research have begun to shed light on the potential effects of chess, and hence can guide educators on the most impactful implementation of chess in instruction. Overall, the self-perceived benefits of chess playing were all rated higher for elementary students than for middle or high school students.

Both gender and grade level were found to be significantly related to several of the perceived chess benefits. Specifically for gender, there were differences between males and females on three of the chess constructs: *Enjoyment of chess*, *confidence in chess playing ability*, and *increased engagement in learning*. Males tended to have higher ratings of *enjoyment of chess* and *confidence in their chess playing ability* across all grade levels, while females tended to have higher ratings of *increased engagement in learning* as a result of chess instruction across all grade levels. This finding supports the results of Gobet and Campitelli (2006), who found that females scored significantly higher in their attitudes towards school after the treatment of chess use during instruction than males. Howard (2014) found that females frequently lacked the same innate chess playing abilities as males, often accounting for their differences in achievement and interest in chess activities. Gender differences may also be explained by the variances in cognitive abilities across gender (Gobet, 2019). For example, Gobet (2019) noted that while males tend to perform better in mechanical tests and mental-rotation tasks, females show higher performance in tasks related to “recognition, episodic memory . . . and language” (p. 59). These differences can inform and guide educators on the best implementation of chess instruction.

Theoretical Implications

This research directly supports the conjectures made in Chitiyo et al. (2021b) about the potential importance of incorporating chess instruction for students in younger grade levels. Additionally, this research also aligns well with the assertions made in Sigirtmac (2012) about the conceptual developmental benefits of chess instruction for six-year-old students in Turkey. If high levels of improved development are possible for children as young as six, educators have an opportunity to maximize the benefits of chess instruction by incorporating it for students at a young age. Horgan and Morgan (1986) similarly found benefits of further cognitive development and more specifically, performance in acquiring new skills, through chess instruction in young children. They found that children within primary grades performed as well in chess when presented with the appropriate contexts and seemed as capable of developing new techniques and cognitive skills as older students when instruction aligned with developmental stages.

Practical Implications

Knowing that the self-perceived benefits of chess playing were all rated higher for elementary students than for middle or high school students, educators at the elementary level have a unique opportunity to incorporate chess in instruction while aiming to achieve the greatest beneficial impact for students. Additionally, elementary level educators and administrators have a responsibility to advocate for such strategies to set young students on a trajectory for success and achievement. Based on these results, such a path for success could be greatly influenced by student exposure to chess instruction.

This information helps educators shape their expectations when utilizing chess instruction. These results suggest that educators can expect to see more outward enjoyment and confidence in chess from their male students. This can be reassuring to educators with concern for female students who may demonstrate less enjoyment or confidence regarding chess. Instead, educators can look for increased engagement in learning overall for female students when seeking to assess whether students are benefitting from chess during instruction.

Understanding the differences in the perceived effects of chess constructs by different moderating variables will allow educators and administrators to integrate chess during instruction in the most meaningful capacity with the maximum benefits for students. Particularly, these benefits are greatest among elementary school students. If there is a causal link between chess benefits and age, then chess use in instruction could be utilized more in elementary school classrooms, especially when educators would like to see student improvement within one of the identified benefits of chess constructs (*increased enjoyment of mathematics, improvement in academic self-efficacy, improvement in collaborative skills, improvement in organizational skills, enjoyment of chess, confidence in chess playing ability, and increased engagement in learning*).

Limitations and Future Research

As with any observational research, there are limitations associated with this study. First, any associations among variables are complex as there are usually many other variables at play, and it is difficult to make causal connections. Second, the use of self-reported measures to gauge program effectiveness can be unreliable as respondents tend to provide socially desirable responses, a

phenomenon known as *satisficing*. Therefore, one needs to exercise caution when applying the findings of this study to different contexts.

With elementary students appearing to benefit the most from chess use during instruction, further research could be conducted to better understand the lasting impacts of chess use in instruction after use in the elementary grades. These lasting impacts could potentially account for the lower ratings among the benefits of chess constructs for students in middle and high school. Additional research may be guided by these findings that reinforce the benefits of chess playing and expand on the gender and grade-level differences across the benefits of chess playing.

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