Available online at ijci.wcci-international.org

International Journal of Curriculum and Instruction 13(3) (2021) 2482–2496

IJCI
International Journal of Curriculum and Instruction

Teacher perceptions of using chess as a heuristic pedagogical method

George Chitiyo[a], Lisa Zagumny[a], Krista M. Davis[a], Michael N. Littrell[a], Ashley B. Akenson[a], Kevin Besnoy[b], Allen M. Mathende[a], & Kinsey Potter[a]

[a] *Tennessee Technological University, 1 William L Jones Dr, Cookeville 38505, United States*

[b] *The University of Alabama, Tuscaloosa 35487, United States*

Abstract

The purpose of this study was to investigate the experiences and perceptions of teachers who used chess during instruction for an entire academic year in several school districts within a southern U.S. state. Data for the study were obtained via an electronic survey administered to a sample of 62 teachers in Spring 2018. Results of the study showed that teachers were enthusiastic about using chess during instruction, and they had largely positive perceptions regarding the benefits of chess among their students.

Keywords: Chess playing; teacher perceptions; chess benefits

1. Introduction

The centuries-old game of chess is viewed by many in educational circles as associated with intelligence, higher order thinking, and better student learning outcomes. Based on the perceived benefit of chess to improve student academic outcomes, several countries have begun implementing the game in schools. These countries include the United Kingdom, Spain, Turkey, Germany, Italy, Venezuela, Armenia, and Hungary (Jerim et al., 2018; Sala & Gobet, 2016). A number of studies such as Ferguson (1986), Aciego et al. (2012), Trinchero (2013), and Kazemi et al. (2012) have suggested that chess benefits students in terms of their academic outcomes and higher-order thinking skills. Evidence regarding the benefits of chess with respect to students' educational and cognitive outcomes, however, is mixed (Aciego et al., 2012; Chitiyo et al., 2020; Gardiner et al., 2019; Jerrim et al., 2018). Where positive impacts exist, the effects are usually small (Trinchero, 2013). In spite of mixed evidence, perceptions about the benefits of chess seem to be overwhelmingly positive.

1.1. Academic and other learning outcomes related to chess

In a meta-analysis of 24 studies involving 2,788 students in chess intervention groups and 2,433 students in control groups, Sala and Gobet (2016) found that students who were exposed to chess tended to do better in mathematics, reading, and cognitive skills, on average, than those who were not exposed, though the effect sizes were minuscule. After examining 40 effect sizes, they concluded that chess was "no more effective in enhancing children's cognitive and academic skills than many (at least more than 50%) other possible educational interventions" (p. 53). Though some studies have looked at chess as it related to specific academic outcomes (Ferguson, 1986; Jerrim et al., 2016) or critical thinking skills (Chitiyo et al., 2020; Sala & Gobet, 2016), there are many potential outcomes that have not been fully explored in the research, such as creative thinking, logical thinking, intuition, logical reasoning, systemic thinking, strategic thinking, foresight, convergent thinking, analytical thinking, problem solving, and concentration, among others (Gardiner et al., 2019). Similar to Sala and Gobet (2016), Burgoyne et al. (2016) conducted a meta-analysis to investigate the relationship between chess skills and cognitive ability, which they referred to as intelligence. Their sample included 19 studies, all of which included at least one measure of cognitive ability and at least one measure of chess skill. One unique component of their study was an investigation of publication bias analysis, and they reported that there was "little evidence to suggest a systematic suppression of particular effect size magnitudes" (p. 77). Overall, the results of the study showed that chess skills correlated with cognitive abilities, with effect sizes ranging from small to medium. The relationships tended to be higher for younger players.

Jerrim et al. (2018) did not find evidence of improved academic outcomes one year after the implementation of a chess program. Their study was a randomised controlled trial (RCT) with more than 4,000 students in 100 schools in England to determine whether chess instruction was associated with academic outcomes in mathematics, reading, and science. The researchers did not find evidence that the program was associated with improved academic outcomes one year post-intervention. There were also no differences in achievement between boys and girls as well as no relation to socioeconomic status. Jerrim and colleagues (2018) suggested that existing literature may include a number of false positive effects, most likely owing to potentially less robust research designs and small samples. It takes a good deal of practice to become an expert at chess. For example, it takes a minimum of 10 years, or 10,000 hours, to become a chess master (Chang & Lane, 2018; Gobet, 2018; Simon & Chase, 1973). Assuming this to be true, it would be unreasonable to expect substantial improvements in students' learning outcomes after exposure to chess for limited amounts of time.

1.2. Educator perceptions

Very few studies have systematically examined stakeholders' perceptions of chess, particularly educators. A comprehensive collection of articles addressing stakeholder perceptions of chess in education was conducted by McDonald (2000). This collection of evidence was drawn from many parts of the world, spans decades, and includes observations, practical experiences, and rigorous research. Evidence provided in these papers and briefs, some of which was rudimentary and anecdotal, paints a positive picture regarding the perceptions of stakeholders toward chess. Graham (1985) also provided similar instances of teachers' accounts, where they expressed that chess was linked to academic outcomes, social skills, and higher order thinking among their students.

In a large randomized controlled trial (RCT), Jerrim et al. (2016; 2018) worked with teachers who were involved in a chess program and expressed positive perceptions of the program. Teachers not only reported that students' confidence levels, concentration, and critical thinking had improved as a result of playing chess, but also that they believed there was a positive association between these skills and students' academic achievement. About half of the teachers from the sample shared that the program would have positive benefits for students' mathematics achievement, and about a quarter of the teachers felt that the effect size on achievement due to chess intervention would be large. Jerrim at al. (2016) reported that schools, teachers, and students were all engaged, excited about the program, and indicated that the program was yielding positive benefits.

Gardiner et al. (2019) summarized an unpublished 2016 study that explored perceptions of educators and parents regarding the benefits of chess in helping the development of students' critical thinking and problem-solving abilities. According to their results, large percentages of respondents indicated that chess was beneficial to children within their numeracy, literacy, and logical thinking. Trinchero (2013) conducted a large experimental study to examine the relationship between chess training and mathematical ability in children between 8 and 10 years old in Italian schools. According to the report, Trinchero "received only positive responses in accordance with other experiences with chess in schools," (p. 15) which suggests that stakeholder perceptions (including teachers') were positive.

In a study conducted among 246 secondary science teachers to investigate their perceptions of the relationship between the use of games and inquiry learning, one of the key findings was the belief that games would be helpful in facilitating student learning, and that the participatory nature of game play might help students (Mezei, 2015). Mezei used both quantitative and qualitative methods to investigate teachers' perceptions of the relationship between game play and inquiry learning. The majority of teachers (87%) indicated on their survey responses that playing games can help students learn to solve problems in school. Similarly, 74% of them expressed that inquiry activities should include "teaching students how to…analyze…and evaluate data/information" (p. 81).

Mezei quoted an example of an interviewee who described witnessing problem solving while a student was playing a puzzle game: "He is trying to achieve a task...He is problem solving, because…it is the task of trying to do a mission and using the ability to manipulate your environment in order to complete the mission that makes it a learning experience" (p. 103). In summary, the participants largely perceived games to be generally beneficial.

1.3. Transfer of learning

In chess literature, transfer of learning is a common topic of discussion. This concept refers to the transferability of learned skills from one learning or problem-solving situation to another. Sala and Gobet (2016) differentiated between near transfer and far transfer. The former refers to the transference of skills among disciplines that are closely related, like geometry and calculus, while the latter refers to transference of skills among disciplines that are remotely related, like Latin and geography. Sala and Gobet argued that the transfer of learning is difficult, especially in adults. In children, however, there is hope that transfer of learning from chess to other domains is possible, given that children's skills are less context specific than those of adults. For example, Gobet (2018) demonstrated that younger players tended to acquire chess skills faster than older players, lending credence to the theory of the speed of transfer being a factor of age. Gobet (2018), and Sala and Gobet (2016) postulated that chess requires far transfer. This conjecture is reasonable given that there is no obvious causal pathway through which skills transference might take place. Needless to say, there is a dearth of evidence on far transfer.

In her dissertation, Mezei (2015) also alluded to the idea of the need for and importance of transfer of learning from the qualitative responses provided by her teacher interviewees. One of the teachers stated,

> Solving the problem isn't necessarily the primary objective, though. The primary objective is that they think about this screwy example of something semi-real life and come up with a strategy for how to approach it. It's the strategy that is more important than the answer. (p. 103)

Another teacher corroborated this idea of the necessity of transfer of learning by saying, "I think the essence of inquiry learning is if a student can discover a process for themselves, think about how that process leads to finding a general rule that is true and planning how to confirm that with other sources" (p. 103). It is every educator's hope that whatever strategies they employ in the classroom will help students make the connection with the real world. When teachers perceive chess to be beneficial, the inherent implicit assumption is that transfer of learning will almost always occur.

1.4. Study purpose

This study was part of a five-year Chess in Schools program conducted in a southern U.S. state. The study's purpose was to assess teacher perceptions of the benefits of chess after one year of using chess in instruction. While other measures were assessed (critical thinking and 21st century skills), teachers' perceptions of chess instruction's usefulness, including observations of students over the course of the school year, were important to capture and add to the understanding of how chess in the classroom works. Thus, this study focused on the assessment of teachers' perceptions because these perceptions are directly related to the level of teacher buy-in for the intervention, and hence related to how likely they would implement it with fidelity. The specific research question was: What are the perceptions of teachers regarding the use of chess as a pedagogical strategy after its implementation for an academic year?

1.5. The chess in schools program

Volunteer teachers from across the state and spanning several grade levels participated in professional development prior to starting the school year. The four-day workshop included how to play chess and how to use the game in the classroom as a means of teaching curriculum standards, critical thinking, and 21st century skills. The professional development introduced teachers to the game of chess while emphasizing curriculum connections in literacy, math, critical thinking, and life skills. In addition, teachers created lesson plans using chess to teach a subject-specific topic and learned how to use the technology provided by ChessKid, an online playing and tutoring site. Teachers were given flexibility as to how they implemented chess within their classrooms, but they were required to include chess or chess-based lessons at least one to two hours per week during the day and to start after-school chess clubs.

When integrating chess into academic lessons, both teachers and students defined, analyzed, and practiced chess-related thinking skills that would be useful when solving problems or achieving goals in various academic and life situations. Standards-based academic lessons were directly tied to chess using vocabulary, metaphors, comparisons, and even chess equipment as manipulatives to further establish the connections between chess strategies and skills and academic and 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. With this infusion of chess in instruction, the researchers hoped to broaden the disciplined thinking required in chess and to transfer it to other academic learning or problem-solving situations.

2. Method

2.1. Participants

The sample for this study consisted of 62 teachers, some of whom taught students in more than one grade level. This sample made up 90% of teachers who were involved with the intervention program. Of the respondents, 74% (n = 46) were female, 23% (n = 14) were male, and two teachers did not indicate their gender. In terms of chess use, 40% of the teachers had been using chess for less than one year, another 40% reported prior chess use for one to two years, and about 20% had been using chess for three or more years. The distribution of teachers by grade level is shown in Table 1.

Table 1. Distribution of Respondents by Grade Level Taught

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

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

Half of the respondents used chess during instruction. Approximately 9% of teachers used chess in after-school chess clubs, and approximately 40% used chess in both settings. When asked about their 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. The variability in proficiency levels among teachers was not of concern as all teachers received the basic training prior to implementation of the intervention in their classrooms. A rigorous study of teacher perceptions about the use of games for instruction by Mezei (2015) found that there was no relationship between teachers' gaming experience and their perceptions of the usefulness of games for instruction.

2.2. Design, instrumentation, and data collection

Using an *ex post facto* observational approach, the study utilized survey methodology to examine teachers' perceptions of the use of chess in instruction. In collaboration with the Chess in Schools stakeholders, the research team developed a questionnaire with input from program coordinators who worked directly with school teachers. Survey items were generated based on the objectives of the overall Chess in Schools project, whose aim was to establish a deliberate association between chess use and student learning outcomes. The latter include academic content, higher order thinking, and 21st century skills. The instrument included questions about the teachers' experiences teaching with chess and with the chess program in general, as well as their thoughts regarding the benefits of chess for their students based on their observations since they started using chess in instruction. The instrument development process was iterative; the researchers circulated several versions of the questionnaire among the stakeholder team, which included program coordinators and other university faculty with expertise in survey methods. Data collection occurred over a month at the end of the spring 2018 school term. The survey was administered electronically via the Qualtrics survey platform. All teachers who had been using chess during that academic year were invited through email to complete the survey.

3. Results

Teachers used chess during instruction in several subjects, including English language arts, general education, gifted education, mathematics, physical education, science, social studies, and chess programs. Because the majority of respondents (40%, n = 25) used chess during math instruction, all other categories were combined to establish a comparison of mathematics teachers versus teachers of other subjects. Both groups showed similar perceptions of their ability to incorporate chess into their instruction or programs. These percentages are presented in Figure 1.

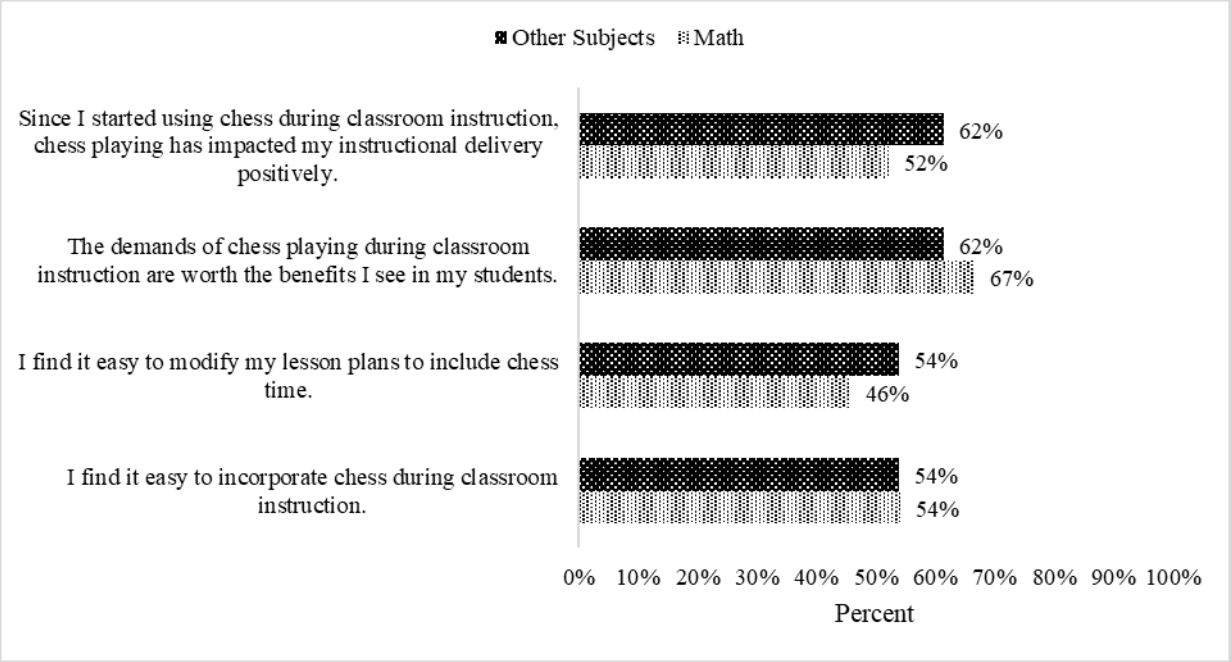

Figure 1. Teacher's perceptions regarding the process of incorporating chess in instruction

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, among all teachers, 57% indicated that chess playing during instruction had a positive impact on their instructional delivery. In addition, a majority of the teachers (64%) felt that since they started using chess based instruction, the demands placed on their instructional time were well worth the benefits they saw in students.

In response to an open-ended question, teachers who used chess during classroom instruction reported that they struggled to find adequate time to prepare to use chess in instruction, and that feelings of stress influenced their method(s) of lesson delivery. Despite this, they reported that 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 that they observed an increase in experiential learning and critical thinking strategies in students resulting from more focused instruction. From the teachers' perspectives, this contributed to improved critical and higher order thinking skills in students.

3.1. Teachers' overall perceptions of the benefits of chess

The majority of teachers felt 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 enjoyed teaching with chess. The teachers were asked to provide their perceptions regarding the observed benefits of chess as an instructional strategy. Table 2 shows the findings related to these perceived benefits.

Table 2. Teachers' perceived benefits of chess since initiating use

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

Overall, the majority of teachers reported chess provided 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%).

Of 15 potential benefits, five were chosen by less than half of the teachers. From the list of perceived possible benefits, the five lowest ranked were: improvement in students' academic achievement (49%), better time management (48%), students putting more effort in their work (47%), students being better organized (41%), and students being more interested in schoolwork (37%). When asked about the benefits of chess to students

in an open-ended question, teachers reported improved critical thinking, strategic thinking, and problem solving. Teachers also reported observing improved behavior; a greater degree of attentiveness, engagement, and perseverance; and more thoughtful and reflective choices by students.

3.2. Teachers' use of chesskid.com

ChessKid.com is an online platform designed to help children 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). According to the website, the variety of learning tools 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). When teachers in the study were asked about their use of ChessKid.com, most of them (79%, n = 49) reported using the independent practice feature, 73% (n = 45) indicated that they used online videos and lessons, and 52% (n = 32) used independent study. Less than 10% (n = 4) of the sample stated that they did not use ChessKid.com. These findings are illustrated in Figure 2.

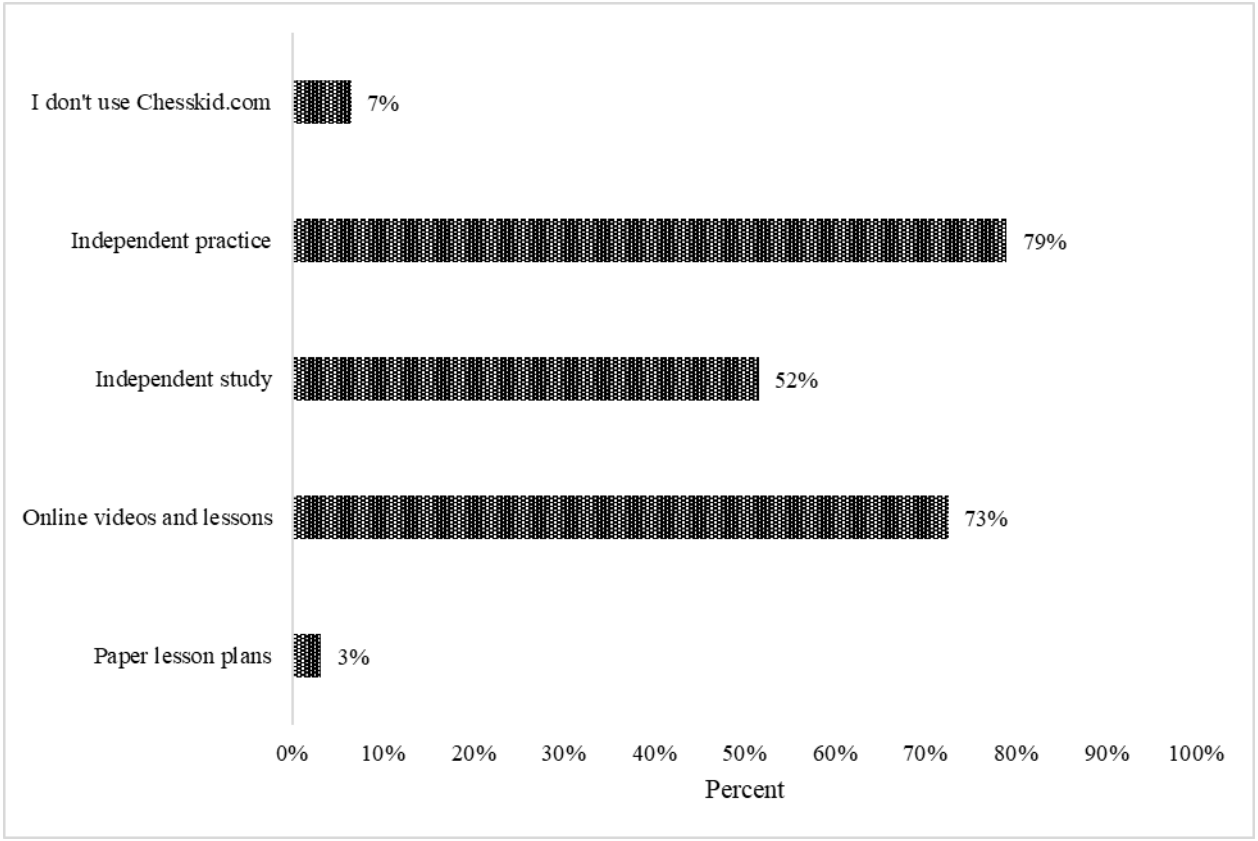

Figure 2. How teachers use chesskid.com

3.3. Challenges from, and benefits of chess implementation

While a few teachers reported no challenges from 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 within 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, such as accommodating students' varying skill levels and overcoming student behavior issues.

When asked for any additional insights about chess instruction or changes in students, teachers made clear that there was some disagreement as to where chess should be incorporated in instruction—homeroom versus physical education. Relatedly, they indicated that starting students at an early age would benefit students as they progressed through the grades where they experienced 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 improved after the introduction of chess. Positive impact on student behavior was another reported benefit of chess instruction. Students became more social and gracious at winning and losing. One teacher stated, "I watched students who were labeled 'bad' turn to chess and do GREAT things." Additional encouraging remarks included teacher comments about how incorporating chess into instruction made them better teachers.

4. Discussion

In the current study, teachers largely indicated that they found it easy to incorporate chess in their instruction, and about 65% of all teachers indicated that the demands of chess playing during classroom instruction were worth the benefits they saw in their students. Half of all teachers found it easy to modify their lesson plans to include chess time. These findings add to the existing body of literature (Gardiner et al., 2019; Jerrim et al., 2016; 2018), where there was previously little information regarding teachers' experiences using chess in instruction.

The majority of teachers in this study viewed chess as providing positive benefits for their students. Using a reference point of when they started incorporating chess into instruction, the teachers felt that their students had become better at problem solving (78%), strategic thinking (75%), thinking critically (73%), and decision making (64%), among other learning situations. The teachers also observed improvements in interest in school (62%), engagement in class (59%), and class participation (58%). These findings align with existing research that links chess playing with improved critical thinking skills (Chitiyo et al., 2020; Christiaen, 1976; Gardiner et al., 2019; Gobet, 2018; Sala & Gobet, 2016) and academic outcomes (Aciego et al., 2012; Fergusson, 1986; Gardiner et

al., 2019). In the current study, 73% of teachers felt that their students had improved thinking critically since they started teaching with chess, which is concordant with Gardiner et al. (2019).

Consistent with existing literature, the present study further supports the finding that teachers and other educational stakeholders tend to view chess playing among students as yielding positive benefits (Graham, 1985; Jerrim et al., 2018; Trinchero, 2013). This is an encouraging finding because prior research has supported the idea that teachers' perceptions and expectations about their students' abilities, in general, are associated with student engagement and achievement in some subject areas (Archambault et al., 2012). Thus, if teachers believe and expect chess in instruction to benefit their students, it is likely that there exists a relationship between positive student outcomes and chess. Future studies should explore nuances of this theory, considering variables like teacher experience level, teacher stereotypes of students, and triangulation with student perceptions.

The positive perceptions by teachers that we found are similar to Mezei's (2015) findings among secondary science teachers, where 87% of them expressed that game playing was beneficial for students and would help them with problem solving. On the contrary, only 2% of the teachers in Mezei's study agreed to the statement that games are for fun, not for learning. In Mezei's study, the teachers' gaming experience did not correlate with their beliefs about the usefulness of games for instruction.

As stated earlier, one comprehensive source of evidence addressing stakeholder perceptions of chess in education was conducted by McDonald (2000). The evidence presented by McDonald corroborates the views espoused by the teachers in our sample. Despite being anecdotal, almost all the sources reviewed show that teachers think chess benefits students in terms of their academics, social and emotional development, and critical thinking, among other higher order thinking skills. Graham (1985), editor of the Virginia Chess Federation Newsletter, provided some anecdotal and isolated instances of several teachers who expressed how they thought chess was beneficial for their students. One teacher is quoted by Graham as saying that chess is "probably the best game there is for developing logical, precise thinking." Another teacher is also quoted as saying, "Youngsters who are good in chess will probably be good in math or in any problem-solving situation." Similar examples of these views abound on various informational outlets and in news media as well. The findings from this study corroborate these observations.

While there may be correlations between teachers' perceptions and students' actual learning outcomes, chess playing will not likely result in immediate benefits to students. If any transfer of learning occurs, evidence has shown that it will occur over longer periods of time (Gobet, 2018; Sala & Gobet, 2016, 2017; Trinchero, 2013). Evidence points to small or medium effect sizes regarding the relationship between chess and academic

outcomes (Burgoyne et al., 2016; Sala & Gobet, 2016). Trinchero suggested that the effects of chess playing among children would be realized after training at least 30 hours per year. Similar to the advice given by Jerrim et al. (2019), Gobet (2018) cautioned against making strong claims of the benefits of chess. Therefore, the claims made from the descriptive analyses in this study should not be overstated; however, the findings provide justification for future research in the area of teacher perceptions of chess in instruction as potential predictors of positive educational and social outcomes for students.

5. Conclusion

Teachers expressed that they felt the use of chess benefits students, and though challenging, was worth the extra time it took to implement chess in instruction and in the students' school day in general. Teachers reported gains in their perceptions of 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. Though we were not aware of any other chess tools teachers may have used, ChessKid.com appeared to be a preferred way for teachers to implement chess into their lessons, with only a small number of teachers (7%) indicating a preference for not utilizing this website. Overall, these factors indicate that chess, as an instructional strategy, provided a positive and meaningful education experience for students and teachers.

Acknowledgements

We acknowledge the work of the non-profit Chess in Schools (www.chessinschools.us) team of Nancy Johnson, Jerry Nash, and Neil Dietsch for their contribution to this project.

References

Aciego, R., Garcia, G., & Betancort, M. (2012). The benefits of chess for the intellectual and social-emotional enrichment in schoolchildren. *The Spanish Journal of Psychology, 15*(2), 551–559. doi: http://dx.doi.org/10.5209/rev_SJOP.2012.v15.n2.38866

Archambault, I., Janosz, M., & Chouinard, R. (2012). Teacher beliefs as predictors of adolescents' cognitive engagement and achievement in mathematics. The Journal of Educational Research, *105*, 319–328. doi: 10.1080/00220671.2011.629694

Burgoyne, A. P., Sala, G., Gobet, F., Macnamara, B. N., Campitelli, G., & Hambrick, D. Z. (2016). The relationship between cognitive ability and chess skill: A comprehensive meta-analysis. *Intelligence*, *59*, 72–83.

Chang, Y. A., & Lane, D. M. (2018). It takes more than practice and experience to become a chess master: Evidence from a child prodigy and adult chess players. *Journal of Expertise, 1*(1) 2573–2773.

Chitiyo, G., Zagumny, L., Akenson, A. B., Littrell, M., Davis, K., & Besnoy, K. (2020). *Teaching with Chess: Exploring the Relationship between Chess and Student Learning Outcomes* (Rep.).

Christiaen, J. (1976). *Chess and cognitive development. An experimental psychological study of youths at the end of primary school period* (Doctoral thesis, Gent National University, Gent, Belgium).

Ferguson, R. (1986, April). *Developing critical and creative thinking through chess, report on ESEA Title IV-C*. Paper presented at the meeting of the Pennsylvania Association for Gifted Education, Pittsburgh, PA.

Gardiner, G., Ormsby, G., & Van der Laan, L. (2019). Most people think playing chess makes you 'smarter', but the evidence isn't clear on that. *The Conversation*. Retrieved June 23, 2020, from https://theconversation.com/most-people-think-playing-chess-makes-you-smarter-but-the-evidence-isnt-clear-on-that-119469

Gobet, F. (2018). *The psychology of chess*. New York, NY: Routledge.

Graham, A. (1985). Chess makes kids smart. *KASPAROV. Chess Foundation Europe*.

Jerrim, J., Macmillan, L., Micklewright, J., Sawtell, M., & Wiggins, M. (2016). *Chess in schools: Evaluation report and executive summary*. Education Endowment Foundation.

Jerrim, J., Macmillan, L., Micklewright, J., Sawtell, M., & Wiggins, M. (2018). Does teaching children how to play cognitively demanding games improve their educational attainment? Evidence from a randomised controlled trial of chess instruction in England. *Journal of Human Resources, 53*(4), 993–1021.

Kazemi, F., Yektayar, M., & Abad, A. M. B. (2012). Investigation the impact of chess play on developing meta-cognitive ability and math problem-solving power of students at different levels of education. *Procedia-Social and Behavioral Sciences, 32*, 372–379.

McDonald, P. S. (2000). The benefits of chess in education. *Retrieved from website: ajedrez21. com (http://www. ajedrez21. com/circulares/descargas/BenefitsOfChessInEducation. pdf)*. Chicago.

Mezei, J. M. (2015). *Science Teachers' Perceptions of the Relationship between Game Play and Inquiry Learning* (Doctoral dissertation, Columbia University).

Sala, G., & Gobet, F. (2016). Do the benefits of chess instruction transfer to academic and cognitive skills? A meta-analysis. *Educational Research Review, 18,* 46–57. doi: 10.1016/j.edurev.2016.02.0021

Sala, G., & Gobet, F. (2017). Does far transfer exist? Negative evidence from chess, music, and working memory training. *Current Directions in Psychological Science, 26*(6), 515–520. doi:10.1177/0963721417712760

Simon, H. A., & Chase, W. G. (1973) Skill in chess. *American Scientist, 61*(4), 394–403.

Trinchero, R. (2013). *Can chess training improve PISA scores in mathematics? An experiment in Italian primary schools*. Kasparov Chess Foundation Europe.
