
The Power of Board Games for Multidomain Learning in Young Children

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The authors conduct a broad, cross-cultural review of the literature in fields such as psychology, education, speech-language pathology, early intervention, and library science concerned with board games and learning in young children. They include experimenter-developed and commercial board games and children's learning in mathematics, science, and language, as well as social, emotional, and cultural understanding. The authors discuss findings related to teaching and the classroom, speech-language therapy, intervention programs, and home and community settings such as libraries. Pointing to the nascent nature of the research in many areas, they highlight how board games, especially those featuring cooperative play, can foster multidomain learning and offer promising avenues for future research. **Key words:** board games; learning; play, playful learning; tabletop games; young children

Introduction

IN SUMMER 2019, in a graduate seminar on children's language development, we hosted a series of drop-in Family Board Game Fun events at a local library. Our goal was to promote communicative interactions rich in learning opportunities for children in a playful setting. We decided to do so by introducing families with young children at these events to the many new board games available for children—games that foster different kinds of learning and feature different and engaging themes. These games offered cooperative and competitive play in versions for children as young as two and had short playing times of less than fifteen minutes. To inform and engage parents further at the events, we highlighted different types of learning afforded by the board

games for children under twelve in a set of posters for the events based on a brief literature review.

The board games and the information in our posters proved both new and of interest to many patrons, including parents, teachers, and librarians. Parents who first declined our invitation to drop in, often claimed that their children were too young or that they did not have enough time. When we described the features of our games, many families came to take a look, then chose a game and began playing. The events became a big success, and the room soon filled up with talk and laughter and play with siblings, parents, and grandparents, and play in several languages other than English. Feedback offered to the library was enthusiastic and included requests for a permanent, circulating collection of games.

When COVID-19 forced the library to close, we pivoted to conduct a more thorough and exhaustive literature search and review of learning during board game play for children of elementary school age and younger (two to twelve years old). Our review of this literature considers academic work from both experimental and nonexperimental fields and contributions from more informal sources such as blogs written by speech-language pathologists and other professionals working with children. Although the board games mentioned in these informal sources have yet to attract much academic research, they are extensively discussed informally by the experts in these areas. Moreover, some board game manufacturers already consider children's development in domains such as language when designing their games, even producing pamphlets along with their games with tips for parents (HABA 2016).

We seek to present and summarize these findings about children's learning related to mathematics; science; language; and social, emotional, and cultural understanding. Our goal is to help both academic and nonacademic audiences gain a more detailed picture of what we know so far about young children's learning from board games. Further knowledge and organization of this literature can benefit a wider audience of parents, educators, and other professionals and community members wishing to provide rich learning experiences to children in at least two ways. First, it can offer a wider scope of board game learning to inform a game's design (and to evaluate such games for purchase and use). Second, those observing children playing a game can better understand and recognize the full breadth of rich learning opportunities and experiences taking place. Indeed, our findings both exceeded our expectations in terms of the number of domains and surprised us in terms of the lack of experimental research in some domains, which we suggest worthy of further investigation.

The Landscape of Board Games and the Games Appearing in Our Review

The current board game landscape is vast and diverse. Some may not be familiar with the board game industry and the distinctions made among board games, so we aim to provide a short overview of the types of games included in our review. We focus on the novice with respect to board games and their history because most of the sources we reviewed were written by nonexperts who simply use the term “board game(s)” without further discussion of their types.

To begin, very broadly defined, the types of board games (or tabletop games as they are also frequently called) appearing in this review all fit the following description in line with definitions in the board game field: any face-to-face game played on a surface or table with various accessories, ranging from die, game boards, tokens, and cards (Parlett 1999; Woods 2012).

Also, many of the games we review were developed by researchers and feature a classic positional race style. That is, the contemporary board game market has been divided into three categories (Woods 2012): nonproprietary, classical or traditional games, that is mass-market games produced in large numbers and “constituting the common perception of commercial board games” (15); and games targeted towards a smaller market of “hobby gamers” (15). Although we consider very few classical or traditional board games such as chess or Go, many of the researcher-developed board games do take the form of traditional positional race style games in which players race to be the first to reach the end of the board. Indeed, many are similar to Snakes and Ladders or Candy Land, both of which were also among the first mass-market family games designed primarily for children to play together with parents or under the supervision of other adults such as teachers (Parlett 1999, 347–49).

Finally, one large category of hobby games includes Eurogames, and it may come as a surprise to readers familiar with the contemporary landscape of board games how few of the board games in the studies have the features of newer midtwentieth-century games, especially given the innovation of the past fifty years. Nevertheless, in a few of the experimenter-developed board games we reviewed, we found three key features in midtwentieth-century games, including Eurogames: thematic subject matter, off-board play, and several ways of winning including winning cooperatively (Donovan 2017; Estes 2018; Moriarity and Kay 2019; Parlett 1999; Woods 2012). We describe these three features more fully in sections to follow.

First, in contrast with abstract, older-style positional games, midtwentieth-century games were “chiefly characterized by a thematic subject matter” (Parlett 1999, 9), a subject matter often educational within the category of family games. Theme games often seek to “simulate or represent some sort of real-life activity” (348), and this can range from simulation (involving some kind of practice for real life) to representational (involving a less realistic focus on recreation and fun). In other words, some games represented very specific real-life activities (e.g., bullying) to teach and practice very specific skills and others educated in a less realistic way that emphasized fun.

Second, in contrast to classic board games, twentieth-century board games featured “off-board play” (Parlett 1999, 346), an early example being Monopoly (published first in 1935) in which “the play of the game centres, so to speak, ‘above the board,’ in the minds and interactions of the players themselves” (7), and board position is irrelevant to winning the game. Although the play in many of the board games we reviewed still centers largely on the board, some of it occurs off the board, especially in those games in which children must act cooperatively.

Third, in more contemporary board games, especially Eurogames, there often exist multiple paths to winning, and winning is not everything—how players play the game and make it a positive social experience can matter just as much. The Eurogame *Settlers of Catan* (1995)—originally developed in Germany and titled *Die Siedler von Catan*—sparked a new wave of critical-thinking games built on such new features as free-form boards and using miniature pieces introduced by predecessors like the tabletop war simulation game *Kriegspiel* and the family game *Risk* (Donovan 2017; Moriarity and Kay 2019; Woods 2012).

They were dubbed Eurogames because they had been first developed and introduced in Europe, and Woods (2012) and others (Donovan 2017; Moriarity and Kay 2019) have described some of their key features, including the rare use of dice; a randomized board layout; indirect rather than direct competition to gain resources; the need for planning, critical thinking, and changing tactics; a flexible scoring system and multiple paths to winning that ensure no one player can leap ahead early to win; high quality construction and aesthetics; accessible to many ages; and set and predictable playing times. In some of these board games, players at times must work together to further their individual goals; some may be designed for entirely cooperative play.

The themes and topics of Eurogames are incredibly diverse (e.g., birding,

honeybees, early railroads), and some features are designed specifically to appeal to children as young as two years of age, such as the short ten-minute playing times and large wooden pieces of the cooperative game *First Orchard*, one of several games in the *My Very First Games* series by HABA. In this review, we see games that, for example, address broader themes and require strategic thinking and consideration of multiple factors.

Active Learning in Board Games

Board games can be a very effective means to promote active learning when children “are engaged in some activity that forces them to reflect upon ideas and how they are using those ideas” (Collins and O’Brien 2003, 5). Noda, Shirotzuki, and Nakao carried out a large metareview and effects analysis of twenty-seven studies conducted in educational settings that specifically compared the knowledge of children both before and after they were provided an active board game-based learning instruction versus a passive form of learning instruction such as a lecture. Studies that included children aged four to twelve strongly suggested board games were an effective tool to encourage active learning and the retention of knowledge. They also found that board games helped increase students’ motivation for learning and even lead to positive changes in behavior (Noda, Shirotzuki, and Nakao 2019). These studies covered different types of mathematical and scientific knowledge, but overall the majority consisted of traditional, positional race games in which players progress along a pathway by rolling dice and by answering questions about whatever topic a teacher wished to teach players, all of which produced a sole winner (See the appendix at the end of this article. Note that the board games mentioned in this article that are also included in Noda, Shirotzuki, and Nakao’s 2019 review appear with an asterisk.)

Inside or outside a classroom, games—including board games—can be a form of active, playful learning (Hirsh-Pasek, Golinkoff, and Eyer 2003), alongside free play and guided play. All of these foster learning because they engage children in meaningful and socially interactive fun (Hassinger-Das et al. 2017). Such guided play can help children learn as well as, if not better than, traditional forms of teaching (Weisberg et al. 2015). During children’s board game play, researchers suggest, guided play might be incorporated by teachers or parents asking open-ended questions that help children think more deeply about what

they are doing and help them absorb information at their own pace. Moreover, the roll of dice or the spin of wheels can introduce the element of chance and help reduce adult control even as children maintain a sense of agency and control in guided play (Hassinger-Das et al. 2017). Moreover, in keeping with a much longer view of children's play as important to many domains of learning (Sutton-Smith 1979; Singer, Golinkoff, and Hirsh-Pasek 2006), board games have the potential to promote children's learning more broadly.

The Scope of This Review

Sources

To aid our query into what children can learn from board games, we searched the academic literature using the journal databases of our university's library (e.g., PsycInfo, BioMed, ERIC, JSTOR, MLA, SSRN). We followed up on the studies cited in that literature and conducted further, broader searches via such search engines as Google Scholar and Google, looking for sources like the blogs of speech-language pathologists. For reasons of space—and in line with some definitions of board games (e.g., Parlett 1999)—we have not included games played solely with cards or dice. The studies we reviewed also do not include other types of hobby games, such as war games or role-playing games (Woods 2012), given that they tend to be for adults. Also for reasons of space, we capped the age of children we considered at twelve years, a natural boundary between elementary and middle or high school.

Use of Terms

Readers should note that the use of the term “board game(s)” in the empirical studies we reviewed was often not further qualified according to the typical distinctions made in the board game literature (e.g., traditional, positional, Eurogame, etc.), largely because the authors and audiences for these articles come from other disciplines, such as psychology or education. As a result, when we draw from or quote these authors, we often use “board game” without further specification given its absence in the original source. However, when we found enough information in the sources, we do give short descriptions of the board games (in our text and in table 1) to help readers understand the games' natures.

We qualify the board games as one of three types: experimenter developed

for a particular study and thus not commercially available; author or child developed if created for a purpose other than an experimental study, such as for an observational study or classroom project; and commercially available. When possible, we give the specific name of the board game. In addition, in table 1 when we call a source an experimental study, we present only the results found significant in statistical analyses conducted by the original authors.

Mathematical Learning

Numerical Knowledge

The use of board games to develop early mathematical knowledge is a well-studied topic, but it is one that has taken place almost exclusively within lab or school settings. A large number of studies, across many different countries, have specifically examined numerical knowledge acquired via board games by young children, such as identifying numbers, comparing number sizes, adding and subtracting, and number line estimations.

These studies have primarily used researcher-developed linear or grid positional board games with numbered spaces, and we refer to them as “number board games.” The number of numbered spaces varies, reaching a maximum of one hundred, and the grid sizes range from about five by five inches to ten by ten inches. Some of the grid boards contain extra up and down possibilities similar to Snakes and Ladders. Ramani and Siegler (2008; 2011) pioneered the original number board game designs with fairly short play times (fifteen to twenty minutes). Among four- to five-year-old American children from low-income families, the studies found that after playing a number board game, children’s ability to carry out numerical magnitude comparisons, numeral identification, and number line estimation tasks improved and that this effect was observed up to nine weeks later. Elofsson and her colleagues (Elofsson et al. 2016) similarly found five-year-old Swedish children’s arithmetic calculations improved following number board game play. In other countries, additional research found playing number board games led to significant improvements in three-year-old Canadian children’s ability to complete successfully an object counting task (Dunbar et al. 2017), six-year-old German children’s overall mathematical competencies (Skillen, Berner, and Seitz-Stein 2018), and four- to six-year-old Chinese children’s interest in mathematics (Cheung and McBride 2017). Number board games have also been shown to have benefits

for the numerical knowledge of four- to ten-year-old autistic children (Satsangi and Bofferding 2017). Within the setting of a children's museum, Bustamante and his colleagues (Bustamante et al. 2020) analyzed the effect a life-sized, researcher-developed board game, Parkopolis, had on children's and adults' dialogue and interactions about numbers compared to another exhibit without a board game. Parkopolis generated significantly more interactions featuring such talk (e.g., fractions, patterns) than the exhibit not featuring a board game. Although experimental studies in public settings such as museums are more challenging to conduct, we are encouraged to see learning from board games studied alongside other forms of learning children may gain from museum exhibits (Andre, Durksen, and Volman 2017).

One outcome of this experimental research on numerical learning from board games has been the "cognitive alignment framework" (Laski and Siegler 2014, 853), which states that the more precisely the physical materials and learning activities are aligned with the desired mental representations, the more likely students are to acquire these representations. So, for example, using a researcher-developed Race to Space positional board game with a grid of ten-by-ten-inch squares numbered one to one hundred, Laski and Siegler (2014) compared the effect of asking five-year-old children to "count-on" from their current number on the board (e.g., from square five, a child rolls a two and counts-on six, seven) versus the more usual "count-from-one" strategy (e.g., count one, two, after rolling a two). The strategy of counting-on resulted in more mathematical learning than counting-from.

To date, few studies have considered how, or why, board game play at home may impact children's learning of mathematics. Some studies suggest that how often board games are played may matter. Among five- to six-year-old Italian children, the frequency of board game play at home was positively related to their counting ability (Benavides-Varela et al. 2016). Similarly, among American children four to five-and-a-half years old, greater numerical knowledge positively related to the number of settings in which they had played commercially available board games, either at their own homes or at the homes of others, and to the very mention of playing Chutes and Ladders. Board game play at home was also more frequently reported for preschoolers from middle-income than preschoolers from low-income backgrounds, even when the middle-income children were younger (Ramani and Siegler 2008, 2011).

In line with the cognitive alignment framework, Ramani and Siegler (2008, 2011) suggest that the experience of playing board games at home such as Chutes

and Ladders, which more closely align with the specific design features of their researcher-developed number board games, relates to greater numerical knowledge among preschool-aged children, particularly for those from low-income homes. Furthermore, they suggest that board games in which children have to roll dice or twirl spinners, translate the dots into a number, use that number to count out how many spaces to advance on the board, and receive multiple kinaesthetic cues (such as hearing the names of the numbers or seeing the difference in length of distance moved with increased value of numbers) are likely to develop children's numerical knowledge. At present, however, these hypotheses remain to be supported experimentally.

Mathematical Reasoning and Problem Solving

Among older elementary school-aged children, board games have been used mostly within school settings to develop mathematical reasoning and problem-solving skills, including the use of abstract strategies and different types of reasoning such as inductive, metaphoric, or imagistic. But findings to date suggest methods with more in-depth analyses of strategies and reasoning may be required to understand how board games can foster these skills. For example, when an intervention with elementary school-aged children has simply consisted of learning to play a game such as chess, findings are mixed: one study found a subsequent effect on mathematical problem-solving scores (Sala, Gorini, and Prevettoni 2015), and another suggested no such effect (Sala and Gobet 2017), both with few further conclusions possible. Other sources describe how board games can be used by teachers in a math class. For example, Ascher (2001) describes teachers using such questions as “How many intersection points does the configuration contain?” (98) in connection with Mongolian game boards to help develop elementary school-aged children's geometric and logical thinking in relation to different polygon shapes of the game boards. But, no data was collected to show if and how such learning occurred.

In contrast to these studies, McFeetors and Palfy (2018)—by employing a much more detailed qualitative analysis of children's verbal reasoning while playing board games—were able to show in much more depth how board game play can help develop children's mathematical reasoning and problem solving. They used methods grounded in Dewey's (1938; 1997) theory that students learn through active participation, collaboration with peers and the teacher, and reflection by the learner that ascribes meaning to the activity. Thus, they had students from grades five and six in a math class play four commercially

available board games that required the use of increasingly abstract strategies—Gobblet Gobblers, Othello, Tic Tac Toe, and Go. The researchers were interested in seeing whether they could observe and document children’s use and growth with respect to different kinds of reasoning important to solving mathematical problems such as inductive, deductive, metaphoric, analogic, imagistic, indirect, and informal reasoning.

And indeed, by using multiple forms of qualitative data—such as children’s verbal answers and explanations to teachers’ and peers’ questions about the strategies deployed, including drawings to support their ideas—they were able to capture forms and verbs of reasoning demonstrated by students. They were also able to show how this classroom intervention with this set of board games led to growth in students’ emergent reasoning ability and strategy use and development. The following detailed description provided by McFeetors and Palfy of one student’s experience playing the game Go illustrates the point. The student, Renée, first showed her skill at refining and modifying existing strategies when playing Othello. But when her group moved on to the more challenging game of Go, she started to analyze the rules and board arrangement possibilities which she explained using metaphoric reasoning (e.g., “to make a wall” [118, figure 5]). She then began using metaphors as reasoning for certain moves and conjectures of what might be an effective strategy for game play (e.g., “to capture the other player and mark territory” [119, in figure 6]). These conjectures eventually led to greater imagistic reasoning and generalized strategic claims employing inductive reasoning.

After playing the game over the nine, one-hour sessions, Renée could justify her strategies and explain how they could be used by other students. Renée’s is but one of several examples of rich mathematical reasoning during play with these board games observed in this unique study.

Summary

Overall, the enhancement of children’s mathematics and problem-solving skills by playing board games depends specifically on the type of game—that is, researcher-developed board games designed for this enhancement, as are number board games—and played in a certain way (such as with specific feedback for particular types of errors). The use and investigation of commercially available board games for mathematics and problem solving appears much less frequently in academic and nonacademic sources. One notable exception is McFeetors and Palfy’s (2018) in-depth investigation of children’s reasoning when

playing with a set of commercial strategy games. They note that ideas for using commercial games more generally to promote mathematical reasoning (e.g., Farkle, SET, Rush Hour) have been shared by teachers but that they are not often the subject of systematic research.

McFeetors and Palfy (2018) also reflect on the potential advantages of using commercial board games in the classroom. They argue that such games promote student activity via their interactive nature and that their availability outside the classroom leads to their perception as “authentic” board games. Indeed, McFeetors and Palfy observed that children were immediately engaged by the board games. They talked about playing them at home, some began to play them outside of school, and they liked that the games were not developed for one specific mathematical idea.

Science Learning

Much stronger support exists for the use of board games as a tool to help students increase their knowledge of scientific topics such as biology and nutrition. Pappalardo, Danish, and Phelps (2013) say such games help students make “deep connections to disciplinary content” (686). Students use this knowledge to motivate behavior change and understand complex systems. Interestingly, with respect to learning about complex systems, collaborative board game play may hold an advantage over competitive game play.

In learning disciplinary content, for example, sixth-grade children showed gains in their knowledge of anatomy and physiology, diet, and lifestyle risk factors after playing a researcher-developed health-themed board game, *Lifestyles*, compared to a group receiving regular classroom activities (Bartfay and Bartfay 1994). Wulanyani and associates (Wulanyani et al. 2019) used a *Snakes and Ladders*-style, researcher-developed game to educate elementary school-aged Indonesian children about the soil parasite taeniasis. The authors concluded that the board game may be a promising learning tool, given children’s correct answers increased from 40 percent to 59 percent after playing the game in small groups.

Noda, Shirotaki, and Nakao (2019) found that board game play helped increase the motivation of students for learning and even led to positive behavior changes. For example, teachers noted a growing interest in and appreciation of nutrition by eleven- to fourteen-year-olds after they played the researcher-

developed positional board game, Kalèdo, in which they learned about energy intake and expenditure via a Mediterranean diet (Amaro et al. 2006). Moreover, in a very large longitudinal study conducted with over thirteen hundred, nine- to nineteen-year-olds in twenty Italian schools, the group who played Kalèdo showed improved nutrition knowledge and dietary behavior over six months and significantly lower BMI z-scores than the control group receiving no intervention (Viggiano et al. 2015).

In another uniquely in-depth study that involved detailed recording and examination of children's talk with peers, Peppler, Danish, and Phelps (2013) observed how greater scientific learning (especially learning about complex systems) may occur when children play board games collaboratively rather than competitively. The study used its own researcher-designed positional board game, HIVEMIND, in a classroom setting to teach six- to nine-year-old American children advanced scientific knowledge about honeybees and their collecting of nectar and how this communal behavior of bees constituted a "complex system" (687).

To engage the children in complex-systems thinking, the game incorporated randomness and probability—for example, a bee does or does not observe the dance indicating the nectar's location—so students could assess its impact on the system of nectar collection. The study also explored whether playing the game collaboratively (single team score sheet) or competitively (individual score sheet) affected peer discourse during play, subsequent post-play debriefings by the teacher, and children's learning outcomes. It found that children playing collaboratively discussed scientific content and made pattern inferences significantly more often than those playing competitively. For example, the collaborators noticed that not all scout bees found a flower with nectar, which affected nectar collection and the winter survival of the hive. The collaborating children more frequently read the cards with scientific information out loud together, stayed on topic, discussed their scores as a team, remained engaged in the game, and proved more active listeners compared to the competitive group, who also, for example, showed little interest in the turns of others. All these collaborative behaviors may have promoted greater learning of the material, which the authors also attribute to the way collaborative play aligned with the collaborative nature of the complex system being examined (i.e., bees working together to collect nectar).

When we consider the benefits of board games for scientific learning among much younger children, we find it interesting to note that some com-

mercial board games may introduce scientific knowledge in a playful manner to two- and three-year-old children. For example, the same topic—honeybees’ nectar collection—is the focus of Hanna Honeybee, a HABA game targeted at children as young as two and part of HABA’s My Very First Games collection. Concentrating not just on honeybees’ nectar collection but also on how nectar



Figure 1. A three-year-old playing HABA’s Hanna Honeybee during a family board game event at Kitchener Public Library. Photo taken by Daniela O’Neill on June 19, 2019, and provided with permission of parent.

is turned into honey in the beehive, players work together to produce as much honey for the honeypot as they can before too many flowers wilt and fall out of the game determined by the roll of the die. Players use a large wooden bee to fly to different flowers to collect nectar, fly the flower token (i.e., nectar) to the three-dimensional beehive constructed from the box, deposit the flower token, and watch a honey token emerge from the beehive to put in a honeypot. Inside the box, the mechanism flips the token from flower to honey side before it reemerges. (See figure 1.)

Like other games in HABA's My Very First Games collection, Hanna Honeybee comes with a pamphlet for parents that indicates how the game can help foster a child's development in color recognition and identification, fine motor skills, communication, and other areas. This pamphlet (HABA 2016, 4–7) also provides tips for parents on how to encourage learning and discussion, which include specific steps parents can take when they play the game with their children (e.g., "Talk about Hanna HoneyBee, how she flies from flower to flower collecting sweet nectar to bring back to the hive" [4] or providing explanations such as what the wilted flower on the die means: "one flower is already wilted and has no more nectar" [5]). Perhaps future research could consider whether even very young children can learn complex systems through cooperative play at home or with peers in a classroom setting with a commercially available game like Hanna HoneyBee.

Summary

When board games are tailored to specific concepts, such as complex systems in science, they can be used to help children learn these concepts (Peppler, Danish, and Phelps 2013). Other than mathematics, most board game studies consider scientific thinking, and the findings of those we reviewed suggest that board game intervention can lead to significant gains in the learning of scientific information—for example, increased knowledge about nutrition and diet (Amaro et al. 2006; Viggiano et al. 2015). Peppler and colleagues call for more research to determine best practices for board game use as a teaching tool in the classroom, especially since competitive play led to less learning and more tension among players (Peppler, Danish, and Phelps 2013). In addition, educators may have to juggle student preferences for commercial games, which parents and children sometimes viewed as more accessible, fun, and authentic. We add that much remains to be explored concerning cognitive and scientific learning within classrooms and also within informal home settings.

Language Learning

Vocabulary and Discourse

Studies show that children's early vocabulary and their later, more sophisticated discourse skills, such as maintaining a conversation or telling a story, can be fostered by playing researcher-developed and commercial board games. Within the domain of speech-language pathology, in particular, commercial board games are recognized as a means to develop these skills further during interventions (Poss and Bugaj 2020).

Hassinger-Das and her colleagues (Hassinger-Das et al. 2016) investigated a board game intervention aimed at increasing the vocabulary knowledge of four-year-olds. Children participated in shared book reading followed by definition review and guided play either in the form of a researcher-developed vocabulary review game modelled on Snakes and Ladders or a nonvocabulary researcher-developed version of the game. The vocabulary version of the board game contained ten squares on which children were asked a question related to a word they had encountered in the book. The questions ranged from low to high demand (e.g., "Can you point to the lane in the book?"; "Why might you make a fierce face?" [75]). At posttest, children in the vocabulary game group demonstrated greater gains in receptive and expressive knowledge of the words taught than those in the comparison group.

Along with other toys and playful activities, speech-language pathologists use commercially available board games to build children's language and communication skills and to meet specific goals in intervention and therapy with children. In reviewing personal sites and blogs, with respect to early vocabulary development, we noted they frequently recommended Candy Land to help children learn vocabulary related to colors and candy (Galstian 2018). Poss and Bugaj (2020) describe how many board games can provide numerous, similar opportunities to model and target vocabulary and short phrases (e.g., get, take, who, your turn, do you want) as well as possible new words (e.g., troll, princess).

Turning to more sophisticated, later developing language skills, Sorsana, Guizard, and Trognon (2013) explored expository discourse skills among ten trios of French four- to six-year-old children by having one child (the expert), who had learned how to play a researcher-developed game "similar to the Game of Goose" (1457), explain the rules and then teach it to two children (the novices) who were unfamiliar with it. Successfully explaining a game relies on sophisticated pragmatic language skills such as taking the others' perspective, monitoring

understanding and errors, providing clarifications if needed, and understanding more complex vocabulary and syntactic structures. As the authors state, “In order to do this, both linguistic, cognitive, as well as interpersonal skills are mobilized” (1455). The study revealed that expert children demonstrated such skills, explaining on average seven of eleven rules and answering approximately 90 percent of their playmates’ questions.

Toe and Paatsch (2018) explored expository discourse skills with Australian eight- to thirteen-year-old peer dyads, one an expert and one a novice. The dyads included one child who had normal hearing and one child who was deaf or hard of hearing (DHH) in both roles to compare their expository abilities to convey the key elements and rules of the commercial board game *Secret Square*, a game in which children seek a token hidden under one of twenty-five small pictures by asking yes or no questions. Despite differences in succinctness and frequency, overall, both groups of children understood and communicated the key features and rules of the game, and experts checked for understanding while novices sought clarifications.

Speech-language pathologists have often recommended *Clue* to help older children develop the ability to formulate and answer questions and communicate their reasoning (Fors 2018). Although they suggested no specific board games to help children build narrative skills, *Eeboo’s Fairytale Spin to Play*—a board game we used in our library events—provides a fitting example. Children spin for a story background picture (e.g., castle scene), heroes and villains, and other story elements. When they have collected all the story elements, they are encouraged to make up a story to share with the players, something we saw children do enthusiastically. Some board games directed more at parents also include instruction booklets with ideas and tips that encourage the playful development of language skills while playing the game with a child, much like *HABA My Very First Games*.

Learning a New Language

Board games can also offer a way for children to practice a new language in a low-risk, fun environment (Smith 2006). Key features of board game play can align uniquely with—and be supportive of—the process of learning a language, helping provide the classroom atmosphere teachers wish to create. Students in language-learning classrooms must feel they can take risks, make mistakes, be creative in practicing new words and sentences, and feel “psychologically comfortable and safe in their learning environment” (Ely 1986, 23).

There are several reasons board game play matches these aims (Smith 2006). First, the vocabulary and discourse tend to be more constrained and easy to understand and predict, which can reduce players' anxiety about speaking in an unfamiliar language. Second, board game play supports symmetric turn taking, which provides all players with a turn to talk, generates repetition that lets players hear the language forms several times, and creates a more relaxed atmosphere. Third, if the board game has a collaborative feature, it can encourage both joint problem solving and experimenting with new language structures and vocabulary related to the game.

In Smith's study (2006), she observed four schools in the United Kingdom where seven- to ten-year-old children played the researcher-developed board game *Have Fun with Verbs* to explore the interactive behaviors of bilingual learners. The game's sentence-construction task encouraged such experimentation, creativity, and play with language because of the supportive help and encouragement of peer players. And indeed, students worked together to solve the language problems, offer feedback and suggestions, experiment with constructions, and react positively by nodding, clapping, and laughing.

Summary

When we consider the role of board games in enhancing language and communication skills, we find it striking that they are being used in many different contexts for a wide variety of skills ranging from enhancing early vocabulary to developing sophisticated grammatical and discourse skills. The detailed analysis of interactions during board game play in some of these studies have revealed areas of difficulty with language and communication hitherto less recognized, which now require specific assessment and potential intervention (Toe and Paatsch 2018). For example, we need to create authentic communicative experiences to reveal more accurately the abilities of students—especially those who may be neurodivergent, shy, or reticent—to teachers who otherwise may have fewer means of evaluation (Toe and Paatsch 2018; Smith 2006). And we should consider the possibility of capturing “the dynamic process of learning ‘in action’” (Smith 2006, 434).

We should note that most of the board games in these studies have been researcher developed to align with language skills being taught. And this is viewed as key to the positive findings by these authors. In fact, in this literature, the term “intrinsic integration,” coined by Kafai (1996) is used to describe situations in which a game's design features and structure are well aligned with the

educational content to be learned (Hassinger-Das et al. 2017). Whether using commercial games would result in similar findings has received little study, and at present, arguments for their usefulness depend largely on some board games receiving positive recommendations from the professional community in descriptive articles (Poss and Bugaj, 2020) or informal sources such as blogs, podcasts, or social media. These recommendations could serve, however, as a basis for further exploration of particular board games or a particular genre of board games (e.g., storytelling).

Social, Emotional, and Cultural Learning

Social and Emotional Learning

Social and emotional learning (SEL) is generally viewed as encompassing five key skills: self-awareness, self-management, social awareness, relationship skills, and responsible decision making (Weissberg et al. 2016). And many researchers believe board games afford rich learning opportunities for SEL both inside and outside the classroom, such as in clinical or therapeutic settings.

Two larger reviews exploring the role of games in playful learning (Hassinger-Das et al. 2017) and social and emotional learning (Hromek and Roffey 2009) have mentioned board games and SEL. Hassinger-Das et al. (2017) suggest that, even when games are not designed to do so, the need to adhere to a particular set of rules and to take turns may be one reason the games effectively foster self-management skills such as self-regulation. Moreover, games that involve multiple players “inherently offer opportunities for social interactions and practice in turn taking, communication, negotiation, and conflict resolution, and empathy” (200).

Hromek and Roffey (2009) argue that “the natural affiliation between children, play, and the desire to have fun with others makes games an ideal vehicle for teaching SEL” (626), including such skills as regulating negative emotions, taking turns and sharing, and treating others in a fair, just, and respectful manner. The authors point out that even just allowing children to decide themselves who will go first can provide a valuable opportunity for young players to balance fairness, self-interest, and their emotions.

Cooperative board games, in particular, may offer valuable opportunities for children to develop socio-emotional skills. Cooperative games are now a prominent and growing alternative to competitive games available commercially

(Jolin 2016), but this style of game is not limited to adult players. Cooperative games designed for families (and children even as young as two) have been steadily gaining traction. Cooperative board games involve all players working together to reach a common goal (Bay-Hinitz and Wilson 2005). The players work as a team and share the payoffs and outcomes. Thus, if the team wins, everyone wins; if the team loses, everyone loses (Zagal, Rick, and Hsi 2006). Indeed, a tension between short-term goals and longer-term goals can arise in cooperative games, so that the “group dynamics can get more complicated, not less” (51) in cooperative- versus competitive-style games (Moriarity and Kay 2019; see also Erway 2018).

As we have described, play interactions of six- to nine-year-olds with HIVEMIND differed in its competitive and its cooperative versions (Pepler, Danish, and Phelps 2013). With respect to team play and affective aspects, positive comments to others on their team (e.g., “go, team, go”) and a greater number of shorter, productive rounds occurred more frequently with collaborative play. Zan and Hildebrandt (2003) found that among younger children dyadic interactions displayed more developmentally advanced reciprocal negotiations and shared experiences during cooperative play. The study observed these interactions as first-grade children played two researcher-developed board games that had similar rules, board game design, and ways of movement, but differed in theme and in goal structure—cooperative (Homesteader) or competitive (Badgers). Interestingly, the researchers did not use commercially-available cooperative games because they were unable to find equally challenging competitive games (Zan and Hildebrandt 2003), a limitation that may have changed in the intervening years with many more cooperative strategy games now available. Bay-Hinitz and Quilitch (1994) and Bay-Hinitz and Wilson (2005) used sets of commercially available cooperative board games (Max, Harvest Time, Granny’s House, Sleeping Grump) and competitive board games (Candy Land, Chutes and Ladders, Aggravation and Double Trouble) along with physical games with four- and five-year-old preschoolers. Unfortunately, the studies do not separate the results for board games and physical games, although they did find that aggressive behaviors decreased from baseline during collaborative play as cooperative behaviors increased. In competitive games, friendship status may also play a role. Nine- and ten-year-old friend dyads argued more about conflicting rules in a researcher-developed positional Snake Pit board game than did nonfriend dyads (Hartup et al. 1993).

Board game intervention may also increase empathy and the awareness

of bullying. In a classroom setting, Nieh and Wu (2018) found that eleven- and twelve-year-olds who played a researcher-developed collaborative bullying awareness-themed positional board game, *Galaxy Rescuers*, demonstrated greater knowledge about bullying and changes in bullying attitudes and empathy compared to a group taught using conventional methods.

Beyond the classroom, board games also find use in clinical and therapeutic settings to meet social and emotional learning goals for children. Speech-language pathologists also frequently use (and recommend) commercially available board games (among other games) to teach and build social-interaction skills in young neurotypical and neurodivergent children such as autistic children and children with ADHD (attention deficit hyperactivity disorder)—skills like turn taking, joint attention, and nonverbal communication, as well as other social skills such as the control of impulses (Katie 2013). In psychotherapy, commercial board games (defined as any structured game with rules, such as *Candy Land*) can be part of the treatment itself because they allow young patients to work through many of the developmental goals of middle childhood including learning to sit still and wait for a turn, share with other players, restrain impulsive behaviors, delay gratification, and tolerate losing (Bellinson 2013). In particular, Bellinson notes that observing how children bend the rules (e.g., refuse to land on spaces that might send them back to the start) can be revealing about whether they feel frustrated and overwhelmed in their everyday life and will benefit from practicing alternative strategies. These strategies then take place in a low-risk setting where young patients receive adult modelling and help develop such skills further (e.g., tolerating setbacks).

In clinical contexts, board games can be also be tools for socio-emotional development. Fernandes, Arriaga, and Esteves (2014) used a researcher-developed *Adventure at the Hospital* intervention with nine- to eleven-year-old Portuguese children facing surgery to evaluate an educational set of materials provided in one of three forms (booklet, board game, or video). These educate children about seven stages related to their hospital visit as compared to a set of materials focused solely on entertainment (e.g., *Snakes and Ladders*). Children's worries were significantly reduced after playing any of three educational set of materials, and this decline was not seen with any materials in the entertainment set. In another study, six- to seventeen-year-olds with ADHD were taught chess by an expert for eleven weeks, and they showed a significant decrease in inattention and hyperactivity-impulsivity between pretest and posttest scores (Blasco-Fontecilla et al. 2016).

Summary

We see again that, with respect to social and emotional learning, board games (both researcher developed games and commercial ones) can be used in a wide variety of contexts (e.g., school, therapy, intervention) to help foster early social and emotional interaction skills in children. However, this area of learning has been studied in much less depth than others and remains practically unexplored in more informal home and community settings. Hromek and Roffey (2009) remark that for more than fifty years, games have lacked attention from psychologists and education researchers. But as our review shows, this has been changing since 2009. More recent studies have revealed what specific interaction and socio-emotional skills may be enhanced by board game play, while also taking into consideration differences that might arise as a result of competitive versus cooperative game play. This limited research suggests board games can provide benefits for children's social and socio-emotional development, bolstered by consistent recommendations of their use by professionals working with young children. Future research, especially involving detailed analyses of interactions and use of the increased commercially available cooperative board games (and Eurogames) with their focus on maintaining a positive interaction for all players will strengthen these findings.

Sociocultural Learning

Beyond individual children and classrooms, playing board games can be a way to build and strengthen social relationships and social cohesion in families and communities (Krishnan 2019). After-school programs are an important informal setting for children's learning and engagement (Lee and Hawkins 2008). A Swedish survey study found staff at children's leisure-time centers used board games with their six- to twelve-year-olds to help children become acquainted, learn social skills (e.g., taking turns), learn to think strategically and be challenged, and as a substitute for digital games (Haglund and Peterson 2017). In libraries, board game programs have also historically been part of services for more than 150 years, with game rooms created in the midnineteenth century to promote social betterment (Nicholson 2013). Gaming programs targeting children appeared in American libraries in the late nineteenth and early twentieth centuries when people believed that games could help children enhance memories and could foster peer relationships (Pierce 2016). The past couple of decades have seen a surge in advocacy for the inclusion of board games in library programs and catalogues (Pierce 2016). A 2007 survey of American

public libraries revealed that more than 70 percent of respondents supported gaming in some way (Nicholson 2013). Board game lending programs, such as demonstrated in Figure 2, now routinely appear in libraries where patrons can sign out a board game just as they would a book (Dolynny 2018).

Museums also offer programs and events at which children and families can play board games. Though long a feature in European museums, such as the Deutsches SPIELEmuseum in Chemnitz, Germany, and the Victoria and Albert (V & A) Museum of Childhood (now renamed the Young V & A) in London, these play spaces now appear in North American institutions, such as The Strong National Museum of Play in Rochester, New York, and the McCord Stewart Museum in Montreal, Quebec. In more informal community settings such as libraries and museums, the popularity of commercial board games has been demonstrated largely through patron surveys. Very limited research has yet taken place in these settings to explore the impact and outcomes of board game play on children’s learning apart from the one study by Bustamante and colleagues looking at numerical knowledge (Bustamante et al. 2020).

A survey of Canadian parents of first-grade children that considered at out-of-school play found parents reported feeling good when their children played board games. Some of them valued this type of play because it built relationships and self-esteem, but others encouraged board game play for academic reasons or for relaxation and fun (Lehrer and Petrakos 2011). Similarly, an interview survey



Figure 2. The web page of Kitchener Public Library announcing the launch of its new board games collection for young children in April 2021.

with parents in Australia, Europe, and the United States revealed that parents viewed commercial board games as an opportunity for multigenerational play between parents and children—and oftentimes grandparents (Rogerson and Gibbs 2018). Board games arguably promote social cohesion among community members throughout various cultures around the world, especially when they involve multigenerational play (Ascher 2001). Board games with design features that easily cross linguistic and cultural borders especially may facilitate social interactions among groups of peoples (de Voogt 2017).

Looking more specifically at family functioning, Poff, Zabrieski, and Townsend (2010) conducted a large study including almost nine hundred American families and found that involvement in a set of eight core family leisure activities—one of which was playing board games more broadly—with various family members not only related directly to higher family functioning, but also to greater and better communication within the family unit, and this was suggested to lead to improved perceptions of family functioning. A 2012 survey of over six hundred American families found that fathers who reported regularly participating in this same set of eight core family leisure activities with their young adolescent children also tended to self-report higher levels of family cohesion and that the involvement of fathers in family leisure activities proved the strongest predictor of family cohesion from the view of both the father and the child (Buswell et al. 2012).

Finally, board games may be an avenue for promoting cultural learning among children. Although the research here is thinner, board games have a long history of being used to help children learn information related to their own country or culture. For example, in Georgian and Victorian times, board games like Wallis's Tour through England and Wales were designed to teach children the geography of these areas, and some incorporated moral values (Dove 2017). More recently, board games have been explored as a way to help children learn important life skills. For example, Zeedyk and her colleagues showed that, after playing a commercially available positional board game focused on road safety procedures, four- to five-year-olds retained the increase in their knowledge for six months compared to a group receiving no intervention (Zeedyk et al. 2001).

When youngsters play board games that originate from a culture different from their own, or feature themes and elements of various cultures, children can learn about these less familiar worlds, and they understand that games are integrated in many different aspects of foreign life and social situations (Ascher 2001). In today's market, however, such games have been almost exclusively

designed for players older than twelve, such as Greenland, which presents players with historically based strategic and logistical challenges (e.g., what to hunt, what technology to use) faced by the Norse, Thule, or Tunit people in the time period depicted by the game.

One noncommercial example is the development of educational board games designed to educate school-aged children visiting the Gummingurru Aboriginal stone arrangement site in Queensland, Australia. These board games are part of a set of learning activities “viewed by the GAC [Gummingurru Aboriginal Corporation] as significant reconciliation opportunities between Aboriginal and non-Aboriginal people” (Ross, Ulm, and Tobane 2013, 66).

Further examples of commercial and noncommercial board games for younger children featuring themes and elements of various cultures appear sparse. The few that we could find include Eeboo’s *I Never Forget a Face*, a memory lotto game featuring children from around the world, and *Indigenous Art Dominoes* and *Indigenous Art Matching Game*, both featuring the artworks of Indigenous artists.

Summary

The use of board games to promote social cohesion and cultural learning has a long history in a variety of settings such as libraries, museums, after-school programs, and in the home, but this use has been the subject of almost no empirical study. The recent appearance of more games for younger children in this domain appears promising, and we believe there remains room for new games and for new empirical work to demonstrate the kinds of knowledge children may be able to gain about their own and other cultures from such games that offer opportunities to strengthen social cohesion inside and outside classroom settings.

Child-Developed Board Games: A Classroom Activity with Many Kinds of Learning

One use of board games as an educational tool to foster almost all of the different types of learning we have discussed involve having children create their own board games to learn about specific topics. Collins and her associates describe a very successful example of this activity for a science unit that took place in a first grade classroom in partnership with Collaborations: Teachers and Artists (CoTA) (Collins et al. 2011). In this project, students developed a life-sized

board game, coined Rainforestland, to learn about the geographic area and ecosystem of the Amazonian rainforest. The classroom itself served as the board and the children as the game pieces. The teacher's goals for this activity were not just related to the science curriculum but also to developing further children's receptive and expressive communication, literacy, visual arts, and positive social-interaction skills. She also sought to engage students across their diverse academic and socioeconomic profiles, to increase participation of learners of English, to promote community and reduce social exclusion.

Students and their teacher worked together to develop the rules and materials of Rainforestland, which was modelled on the popular game Candy Land. Working in pairs, one student acted as the player while another acted as the game piece. Children wore paper *mâché* masks of rainforest animals when they became a game piece. After drawing a card, the player directed the game piece to move forward to a colored square as indicated on the drawn card. Students could also land on "traps" designed after features of the Amazonian rainforest (such as a three-dimensional pit of vipers) and could escape by correctly answering questions related to the rainforest, (such as: "What is the top layer of the rainforest called? Answer: 'Canopy'") (Collins et al. 2011, 18). Students could also take shortcuts. The first team of game piece and player to reach the finish line of the game was declared the winner (Collins et al. 2011).

The children were part of the creation process of Rainforestland at each step—from deciding on the rules, directions, and structure of the game to developing the question cards and materials for the game to finally participating in the actual game play. Their teacher viewed the activity as successful in providing children with a chance to practice and improve their executive functioning skills. These included planning and decision making, logical thinking skills, communication skills (learned via the writing of the rules and questions of the game), learning the content vocabulary, and maintaining positive interactions using social skills such as turn taking when they created and played the board game together.

Conclusion

Board games, as proven by their long history and broad reach across cultures (Attia 2016), are forms of entertainment that engage children and adults alike in a large variety of settings. We believe our review also demonstrates that board

games present opportunities for developing skills in a wide variety of domains of learning in young children. More broadly, they can promote “learning how to learn” (Krishnan 2019; All Aboard Games n.d.).

Several authors have lamented the lack of academic research on board games (Hromek and Roffey 2009; Woods 2012), even declaring it a “dead science” (Ortego-Gimbaldo 2008, 34, cited in Woods 2012, 10). Although it is the case that the largest number of research studies have examined children’s skills and learning in the domain of mathematics, our review has shown that when the literature is surveyed broadly across a number of fields and considers expertise and practice in fields such as speech-language pathology that may be conveyed in more informal or applied sources, a sizable body of evidence emerges that supports children’s learning in a wide variety of domains using board games and in a manner that children still find fun and engaging.

Given that research in many domains with board games remains still fairly nascent (e.g., language learning, social emotional learning) and that much remains to be studied about the benefits of board games as learning tools in many developmental domains (Hassinger-Das et al. 2017), we hope that research exploring the benefits of board games in domains beyond cognition will continue to grow. We believe one challenge of future research will be to find the right balance between board game design and mechanics aimed at promoting teaching skills and the accessibility and authenticity for enjoyable play (Wonica 2015). Given the importance of the latter for children, we believe studies exploring the rich potential of high quality contemporary commercial games—perhaps with simpler, low- or no-cost adaptations to instructions or materials in keeping with the game mechanics—would be particularly valuable for educators, professionals, community organizations, and parents in deciding which games to offer children. Indeed, such studies, we would predict, will show the benefits of board games for young children’s learning to be even more powerful than we have been able to demonstrate here.

Playing board games is an activity in which children and adults spend time enjoyably together. With the hundreds of existing board games focused on various themes, frequent new releases, and the option to play cooperative or competitive games, the choices for shared board game play are many. The expansion of libraries lending out board games and the establishment of more community-based and school-based board game programs has the additional advantage of bringing these rich learning opportunities to families and children in communities at large at little to no cost to individual families. Indeed, inter-

ested readers can view the first collection of board games for young children launched in April 2021 by Kitchener Public Library with curatorial help from Daniela O’Neill at www.kpl.org/board-games and a fuller description of the games, the reasons they were chosen, and related openly available materials on O’Neill’s University of Waterloo Children’s Communication Lab website (<https://uwaterloo.ca/childrens-communication-lab/community-outreach/family-board-game-fun-kpl-board-game-collection>)

The opportunity to borrow new games to play with children at home could not come at a better time given that schools and most community spaces have been long closed because of COVID-19, which has no doubt fueled a larger global resurgence in the appreciation of what board games have to offer.

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APPENDIX

Fuller descriptions of board games in sources reviewed, presented in order of appearance in this article.

Source (age or grade of participants)	Game name	Design type	Description (<i>Publisher</i> , if relevant)
Numerical Knowledge			
Ramani and Siegler (2008; Ex. 1); experimental study (4- and 5-year-olds) Ramani and Siegler (2011); experimental study (3- and 4-year-olds)	The Great Race	Experimenter-developed	Players use a spinner with numbers 1 and 2 and must move their token the correct number of spaces according to the spinner from one end to the other of a horizontal linear board with different colored equal-size squares consecutively numbered 1-10 from left to right. Children had to say out loud the number of the spaces through which they moved (if they could not do so, the experimenter named them and the child repeated the name while moving their token). The first player to reach the end wins.
Elofsson et al. (2016); experimental study (5-year-olds)	Not stated in source	Experimenter-developed	Modelled after Ramani and Siegler (2008; 2011) but with 3 more boards (11–20, 21–30 and 31–40) to extend play and a die with numbers 1 to 3. Children had to count out loud while moving token.
Dunbar et al. (2017); experimental study (3-year-olds)	Not stated in source	Experimenter-developed	Players use a spinner and must count out loud the number of spaces their animals can move according to the spinner from one end to the other of a linear board with spaces numbered 1–20. The first player to reach the end wins. (Modelled after Ramani and Siegler 2008, 2011)
Skillen, Berner, and Seitz-Stein (2018); experimental study (6-year-olds)	100 House	Experimenter-developed	Players must roll a die to move spaces on a 10x10 grid numbered 1–100. First player to reach the 100th square is the winner. If a player landed on a square with a 5 in the unit position, they could move up one floor (e.g., moving from the 15 square to the 25 square). Players were required to count-on in the number sequence or count-from 1 to 10 depending on the condition.

Cheung and McBride (2017; Study 1); observational study (3- to 6-year-olds)	Not stated in source	Author-developed	Players must roll a die to determine the number of spaces they can move on a 5x5 grid. Some spaces moved a player further away from the goal (similar to snakes in Snakes and Ladders) and some spaces moved a player closer to the goal (similar to ladders). The first player to reach the goal won the game.
Satsangi and Bofferding (2017); experimental study (4- to 10-year-olds)	Not stated in source	Experimenter-developed	Same game as used in Ramani and Siegler (2008; 2011).
Bustamante et al. (2020); observational study (typical clientele of museum are 2 to 7 years old)	Parkopolis	Author-developed	Life-sized board game. Players roll die with whole numbers and $\frac{1}{4}$ fractions to move down number line that has spaces divided into fractions. Some spaces direct to game cards with STEM learning activities (e.g., pattern pipes). Rules are open-ended.
Laski and Siegler (2014); experimental study (5- and 6-year-olds)	Race to Space	Experimenter-developed	Players had to spin a spinner to move their token across a 10x10 matrix game board numbered from 1–100. The blue background color of the board deepened every two rows, and the spinner had five sections labeled 1–5. Players were required to count-on or count-from 1 depending on game condition. A figure of the board is included in the source.
Benavides-Varela et al (2016); correlational study (5- and 6-year-olds)	Not stated in source	Not stated	No details provided beyond mention that the games “require children to remember numbers and exercise the counting procedure” (p. 8).

Mathematical Reasoning and Problem Solving

Ascher (2001); report from practice (no specific ages stated)	"Board games of strategy from Mongolia"	Traditional Mongolian games	Game boards are often configured as n-sided regular polygons (see article for figures). Using half of a set of markers that equals $1/2(6n-2)$, a player's goal is to place three markers in a row on intersection points, while interfering with the opponent's ability to place three in a row.
McFeetors and Palfy (2018); observational study (5th and 6th graders)	Goblet Gobblers, Othello, Tic Stac Toe, Go	Commercially available	<p>Goblet Gobblers is a variation of tic tac toe in which bigger pieces can "gobble up" smaller pieces. (<i>Blue Orange Games</i>)</p> <p>Othello: Discs are placed on 8x8 grid to surround and flip opponents pieces to gain territory. (<i>Mattel</i>)</p> <p>Tic Stac Toe is a variation of tic tac toe where pieces can be stacked. (<i>Melissa & Doug</i>)</p> <p>Go: Stones are placed on intersections of 19 x19 board to gain territory and remove opponent's pieces. (See www.usgo.org)</p>

Scientific Thinking

*Bartfay and Bartfay (1994); experimental study (6th graders)	Lifestyles Game	Experimenter-developed	Players try to be the first to collect 10 tokens to cancel out lifestyle risk factors on their score cards by providing correct answers to questions about diet and nutrition, basic anatomy and physiology, and lifestyle risk factors associated with disease. (Not clear in source if players move along game board to be asked questions.)
Wulanyani et al. (2019); experimental study (3rd to 6th graders)	Described as a Snakes and Ladders board game	Experimenter-developed	Game board had 12 squares where players had to draw a card and answer a question. Another player checked the answer. Players moved forward if correct, backward if incorrect.
*Amaro et al. (2006); experimental study (11- to 14-year-olds) *Viggiano et al. (2015); experimental study (9- to 19-year-olds)	Kalèdo	Experimenter-developed (Unclear if available. Contact author S. Amaro)	Players move through board by rolling dice and must balance their total energy supply, denoted by food cards, with their total energy expenditure, denoted by activity cards, to reach daily energy needs. Player who attains maximum points for energy balance, food balance, and food variety is the winner.
Peppler, Danish, and Phelps (2013); experimental study (6- to 9-year-olds)	HIVEMIND	Experimenter-developed	Players must move their bee token on game board using a 6-sided die that determines different paths and outcomes. On certain squares, players receive card with scientific information or directions. Goal is to collect as much nectar as possible. Players assigned to competitive or collaborative scoring condition. Figure of board in article.

Language and Communication

Hassinger-Das et al. (2016); experimental study (4-year-olds)	Not stated in source	Experimenter-developed	Modelled on Snakes and Ladders. Players who land on one of two coloured squares (by spinning a 2-coured spinner) must answer a question about 1 of 10 vocabulary words encountered in a previous book read. Board contained 2 ladders and two snakes. "Bonus" round asked about any vocabulary words not landed on. Figure of board in article.
Galstian (2018); report from clinical practice (no specific ages stated)	Candy Land		Candy Land: Players move spaces by drawing colour cards. The first player to reach the final square wins. (<i>Hasbro</i>).
Sorsana, Guizard, and Trognon (2013); observational study (4- to 6-year-olds)	Not stated in source	Author-developed	Described as "derived from the Game of the Goose but differed in content and form" (p. 1458). There were 11 specific rules, a die with faces of different colours and tokens.
Toe and Paatsch (2018); observational study (8- to 13-year-olds)	Secret Square	Commercial game (unclear if still available)	Players must find a token hidden somewhere in a 5x5 grid of picture squares by asking yes/no questions about the pictures. Authors added the rule that the player finding the token with the least amount of questions, wins. (<i>University Games</i>)
Fors (2018); report from clinical practice (no specific ages stated)	Clue	Commercially available	Clue: Players must try to solve a murder mystery by making guesses involving the location, weapon, and suspect of the crime. Once players have narrowed down what they know to one of each category, they can make an accusation. The first player to make a correct accusation is the winner. (<i>Hasbro</i>).
Smith (2006); observational study (7- to 10-year-olds)	Have Fun with Verbs	Author-developed	Players must move their piece across a board by correctly forming sentences using verbs in the past tense.

Social and Emotional Learning

<p>Zan and Hildebrandt (2003); experimental study (1st graders)</p>	<p>Homesteader and Badgers</p>	<p>Experimenter-developed</p>	<p>Players move their markers on spaces on a board by rolling a die with numbers 0 – 3. Homesteader: Players must work together to collect five food cards to fill a basket and five pieces of wood cards to build a cabin while also restoring environmental damage done as a result, before the environmental damages hit a threshold and all players lose the game. Badgers: Players must try to be the first to collect four baby badgers and four worms to feed their badgers while also restoring a soiled nest with new bedding before the nest becomes too soiled.</p>
<p>Bay-Hinitz and Wilson (1994); experimental study (4- and 5-year-olds)</p>	<p>Cooperative set: Sleeping Grump, Max, Harvest Time, Granny’s House Competitive set: Candy Land, Chutes & Ladders, Aggravation, Double Trouble (not described in original source)</p>	<p>Commercially available</p>	<p>Sleeping Grump: Players must work together to climb to the top of the beanstalk and recover their treasure, all without waking Grump. All players win the game when everyone has some of the treasure. (<i>Family Pastimes Co-operative Games</i>) Max: Players must work together to get all the animals home before Max the Cat catches them. (<i>Family Pastimes Co-operative Games</i>) Harvest Time: Players work together to plant gardens and harvest their crops before winter arrives. (<i>Family Pastime Co-operative Games</i>) Granny’s House: Players must work together to complete the journey to Granny’s house by deciding what items to bring with them and inventing ways to use these items when they reach obstacles. (<i>Family Pastimes Co-operative Games</i>) Aggravation/Double Trouble: Be the first player to move 4 tokens around the board and back to home. (<i>Hasbro</i>)</p>

Hartup et al. (1993); experimental study (9- and 10-year-olds)	Snake Pit	Experimenter-developed	Players must move their markers along the path of the gameboard by spinning a spinner to determine the number of spaces to move. On certain spaces, players must draw cards, which have special instructions for additional movement that players must follow. Players were taught conflicting rules for certain circumstances that appeared every three to seven spaces around the board.
*Nieh and Wu (2018); experimental study (5 th graders)	Galaxy Rescuers	Experimenter-developed	Players arrange map cards of campus to build game board that they move through with dice roll. Players need to collaborate with each other and use defense cards, earned through answering training questions about bullying, to choose between completing their own task assignment or helping a victim of bullying before the victim's mood scale drops to zero.
Katie (2013); report from practice (source aimed toward children aged 3- to 6-year-olds)	The Sneaky Snacky Squirrel Game, Hi Ho Cherry-O!, Richard Scarry's Busytown, among others	Commercially available	<p>The Sneaky Snacky Squirrel Game: Players try to help the squirrels prepare food for the winter by spinning the Squirrel spinner. If the spinner lands on a colour, players can use the Squirrel Squeezer to take an acorn and put in the matching hole in their log. The first player to fill their log wins. (<i>Educational Insights</i>)</p> <p>Hi-Ho Cherry O!: Players must spin a spinner to determine how many cherries they can take off their cherry tree and put into their basket, or how many cherries they must put back on the tree. The first player to collect all the cherries off their tree wins. (<i>Hasbro</i>)</p> <p>Richard Scarry's Busytown: Players must work together to look for hidden objects as they drive across Busytown to the ferry leaving for Picnic Island. (<i>Ravensburger</i>)</p>

<p>Bellinson (2013); report from practice (no specific ages stated)</p>	<p>Mouse Trap, CandyLand, Don't Wake Daddy, Life, among others</p>	<p>Commercially available</p>	<p>Mousetrap: Players must first work together to build a mouse trap on the board. Once the mouse trap is ready, player take turns rolling a dice to move across the board while trying to catch other players in the mouse trap. The last player to be caught in the trap wins. (<i>Hasbro</i>) Don't Wake Daddy: Players must make their way across the board to get the refrigerator for a midnight snack. If a player lands on a space without a color or number, they are safe. If a player lands on a space with a color or number and they don't have a matching card, they have to press the button on Daddy's alarm clock the number of times indicated on the card. The first player to reach the refrigerator without waking Daddy wins. (<i>Hasbro</i>) Life: Players must spin a spinner to move across the board. As they move, they can make choices surrounding their careers, financial moves, and family life. The player who reaches the end of the board with the most money wins the game. (<i>Hasbro</i>)</p>
<p>*Fernandes et al. (2014); experimental study (8- to 12-year-olds)</p>	<p>Adventure at the Hospital</p>	<p>Experimenter-developed</p>	<p>15-min board game (not described further) that educated children about 7 aspects of their upcoming surgery (source contains Appendix with examples of information given).</p>

Social Cohesion and Cultural Learning

*Zeedyk et al. (2001); experimental study (4- and 5-year-old)	Not stated in source	Commercially available in Britain (limited access)	Players try to be the first to get home from school safely by rolling dice and moving their pieces around the board and using their knowledge of road safety to cross the different road crossings safely.
Ross, Ulm, and Tobane (2013); report from practice (no specific ages listed)	A Part of Something Bigger	Author-developed	A positional board game akin to Snakes and Ladders designed to teach school children about the journeys to the Gummigurru stone arrangement site in precontact times. A picture of the game board is available in the source article. More games are available at http://www.gummingurru.com.au/Games .

**Child-Developed Board Games:
A Classroom Activity with Many Kinds of Learning**

Collins et al. (2011); observational study (1 st graders)	Rainforestland	Author-developed	Players try to be the first to move across the life-sized game board by correctly answering questions about the rainforest. Fuller description in text.
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*Indicates a study included in the meta-review by Noda, Shiotsuki, and Nakao (2019)