
Obstacles to the Development of Logical Thinking in Kuwaiti Students

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Abstract

This study aimed to explore the development of Kuwaiti students' logical thinking after the reopening of schools following the coronavirus disease 2019 pandemic. The researchers conducted a qualitative case study utilizing the clinical exploration method to explore 17 students' thinking over a 3-month interval as they played "Lining Up the Fives," a card game. The results demonstrated five distinct levels of logical thinking among the six- and seven-year-old students, ranging from levels zero to two. These levels were lower than expected and were comparatively less than those reported in a study in Japan. Generalization is limited from the study due to the small sample. The Kuwaiti students who began a prolonged absence from the classroom and long-term remote-learning activities based on rote memorization demonstrated unexpectedly low levels of logical thinking. This implied that they lacked sufficient stimulatory physical knowledge activities to develop logical thinking skills. Their long absence from the classroom and resulting remote-learning activities appear to have had a very negative effect on the development of logical thinking skills.

Keywords: Logical thinking, Lining Up the Fives game, Clinical exploration, Remote-learning, Rote memorization, Kuwait.

العقبات التي تعطل نمو التفكير المنطقي لدى الطلبة الكويتيين

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الملخص

تهدف هذه الدراسة الي استكشاف نمو التفكير المنطقي لدي الطلاب الكويتيين بعد استئناف الدراسة الحضورية بعد جائحة فيروس كورونا (COVID-19). أجرى الباحثون دراسة حالة نوعية باستخدام منهج الاستقصاء التحليلي النقدي لكشف أنماط التفكير لدى عينة مكونة من (١٧) طالبا خلال فترة امتدت لثلاثة أشهر، وذلك عبر ممارستهم لعبة البطاقات Lining Up the Fives. كشفت النتائج وجود خمسة مستويات للتفكير المنطقي لدى الطلبة في الفئة العمرية (6-7 سنوات)، تتراوح بين المستوى صفري والمستوى الثاني. كانت هذه المستويات أدنى من المتوقع، وأقل مقارنة بما ورد في دراسة مماثلة أجريت في اليابان. وتشير النتائج ايضا الي أن فترة الانقطاع الطويلة عن التعليم الحضورى، مقرونة بالاعتماد على أنشطة التعليم عن بعد القائمة على الحفظ والتلقين، أسهمت في تدني مستويات التفكير المنطقي لدى الطلبة. على الرغم من أهمية نتائج هذه الدراسة إلا انه ينبغي الاخذ بالاعتبار ان صغر حجم عينة الدراسة يحد من تعميم النتائج. الكلمات المفتاحية: التفكير المنطقي، لعبة Lining Up the Fives، الاستقصاء السريري، التعلم عن بعد، الحفظ والتلقين، الكويت.

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Introduction

Many obstacles exist in general learning and the development of logical thinking among students. They include cognitive, physical, emotional, social, mental health, language-based, cultural, and environmental factors (Pennacchia et al., 2018). Absenteeism and remote learning are specific difficulties involving several factors which obstruct the development of logical thinking.

A growing problem for educators is that absenteeism in K–12 schools is harming student-learning outcomes. Less time spent attending school results in reduced student learning (Goodman, 2014; Hansen, 2011; Marcotte & Hemelt, 2008). Additionally, absenteeism is a strong predictor of dropout risk (Allensworth & Easton, 2007; Balfanz & Byrnes, 2012; Balfanz et al., 2007; Gottfried, 2011). In recent years, the most influential environmental factor affecting school absenteeism was the coronavirus disease 2019 (COVID-19) pandemic (Zhdanov et al., 2022). Beginning in 2020, it created a tremendous upheaval in global societies, economies, politics, and public health systems (Kobayashi et al., 2021). The COVID-19 pandemic has been critically impacting education and is estimated to create the greatest disruption in education worldwide in a generation (Reimers & Schleicher, 2020). According to the United Nations Educational, Scientific, and Cultural Organization (United Nations Educational, Scientific and Cultural Organization, 2020), the COVID-19 pandemic has forced the closure of schools for nearly 80% of the world's student population, affecting 1.37 billion of them, or more than 3 out of 4 children and youth.

Corresponding to the school closures, the amount of student screen time has dramatically increased with remote learning and gameplay. In a recent study on Canadian families, children reported an 87% increase

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in their screen time during COVID-19 (Carroll et al., 2020). Furthermore, a Turkish study found that 72% of the children had a higher amount of screen time during COVID-19 compared to previous years, with an average duration of 6.4 hours of daily screen time (Eyimaya & Irmak, 2021). Increased screen time is likely to lead to many negative risks for children (McDool et al., 2020).

Recent data from the student progress assessments have begun to reflect the grim effects of the pandemic on educational institutions. According to The National Assessment of Educational Progress (The Nation's Report Card, 2022), during the COVID-19 pandemic, 9-year-old children in the United States experienced the largest drop in math and reading scores in 20 years from 2020 to 2022. When comparing high-, middle-, and low-performing students, the low performers showed the greatest decline in scores. According to the 2023 report from Trends in International Mathematics and Science Study (TIMSS), In Kuwait math and science scores continued to be at the bottom of the countries which participated in the study with a further drop in scores between 2019 and 2023 (TIMSS, 2019, 2023). Moreover, there are limited data exploring obstacles to the development of logical thinking of Kuwaiti students after the pandemic. Therefore, this critical exploration aimed to explore the development of logical thinking in six- to seven-year-old children in Kuwait after the reopening of schools.

The COVID-19 pandemic led not only to increased absenteeism, but also increased reliance on remote learning by the majority of school systems to prevent academic losses (Fontenelle-Tereshchuk, 2021). A negative aspect of remote learning is that goals are mainly focused on the rote learning of meaningless information that is only useful for passing tests. Piaget referred to rote learning as "verbalisms" and believed that they lead to short-term memorization. Such short-term memory tasks do not meet the experiential learning needs of children that research and theory in developmental psychology have demonstrated and are therefore not developmentally appropriate (Kamii, 2015a). In contrast, long-term intellectual goals such as reasoning, predicting, hypothesizing, and analyzing lead to the construction of meaningful knowledge and have a higher dividend. Piaget would refer to these long-term intellectual goals as being based

on logical thinking (Guddemi, 2020) that is explained in the literature review.

Literature Review

Piaget's ideas about knowledge are part of his grand theory of cognitive development, which has been an important reference point for researchers for more than 50 years (Kamii, 2015a). Piaget distinguished three types of knowledge: physical, social-conventional, and logical thinking, which Piaget called logico-mathematical (Piaget, 1950, 1951, 1971). Physical knowledge refers to the knowledge of physical objects in the real world, such as comprehending that a cat is soft. Another example is the understanding that objects made of glass can break if dropped. The source of this knowledge is based on the physical properties of the objects. Social-conventional knowledge originates from social conventions that people have developed over time, such as the language one speaks, following the rules of polite behavior in a particular culture, and celebrating holidays. The basis of this knowledge is not from within the individual's mind; it is from other people in the social setting. Logico-mathematical thinking is based on the mental relationships constructed in the mind, such as the difference in the sizes of two camels. Another example is numerical relationships, such as the number three when one sees three marbles. The source of this knowledge is the internal thinking of each person (Kamii, 2015b).

Piaget stated in his book *The Construction of Reality in the Child* (1954) that development of logico-mathematical thinking serves a vital role in a child's construction of all knowledge. Piaget believed that an infant's realization of the consequences of actions represented the development of logico-mathematical thinking, enabling a simultaneous construction of physical knowledge. Piaget stated that to encourage the development of logico-mathematical thinking, children must engage in activities that require active reasoning. Inhelder and Piaget (1958) further explored the construction of logico-mathematical thinking by observing its development in young children as they interacted with a balance scale. The authors observed that the children's thinking processes developed in three basic stages with six

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substages, and knowledge of the law of balance developed when children's thought reached the formal operations stage.

Similar research by Piaget, Grize, Szeminska, & Bang (1977) concluded that physical knowledge and logic-mathematical thinking are inseparable in a child's mind until around the age of five or six. After that age, logico-mathematical thinking begins to differentiate from physical knowledge. In a later study by Piaget, Kamii, and Parrat-Dayana (1980), the authors determined that contradictions between a child's thought and physical knowledge experiences cause disequilibrium in thinking, leading to the eventual construction of new knowledge.

Kato, Kamii, Ozaki, and Nagahiro (2002) continued research on the nature of logico-mathematical thinking by investigating how children's level of representation correlate with their level of abstraction in mathematics. The authors determined that children can represent their knowledge of reality at or below their level of abstraction, but cannot represent their knowledge above their level of abstraction. This result supports Piaget's hypothesis that a child cannot represent number without a development of the logico-mathematical thinking of numeracy.

Kato (2010) explored the representation of logico-mathematical thinking by investigating the relationship between classification ability and illogical behavior in a card game named "Concentration" in children ages 3-6 years. The aim of the study was to explore the correlation of classificatory thinking in preschool children with the logic displayed during a card game. The results indicated that four levels of logico-mathematical thinking were displayed and that illogical strategies in the card game had a statistically significant association with a child's level of classificatory thinking.

Studies on the effects of COVID-19 on young children demonstrate a negative effect on cognitive abilities due to an abrupt and extended halt to educational programs. In a 2020 Turkish study analyzing primary students who experienced school closures due to COVID-19 in 2019, significant learning loss was found. Primary students who were affected by school closure demonstrated learning loss in mathematical reasoning skills when compared to pre-COVID students. This loss was

not mediated by socio-economic status or age. The authors concluded that being deprived of social interaction with teachers was a significant source of the learning loss (Coskun & Kara, 2022).

A 2023 analysis of the effects of COVID-related remote learning and school closures illustrated a significant negative impact on 1st-8th-grade students in Hungary. The impact affected the students' cognitive development in important domains of education leading to declines in school readiness skills and lower performance in 2nd-8th graders reading, mathematics, and science knowledge. Loss of student-teacher interactions and support systems appear to be linked to these declines (Molnár & Hermann, 2023).

Ninety-four children in the US who participated in high-quality early care and education programs before COVID-19 in 1993 were compared to 48 toddlers in the 2020 cohort during the pandemic. The 2020 cohort demonstrated lower cognitive functions than the pre-pandemic cohort of 2019 (Lopez et al., 2024).

In a 2025 scoping review of 13 peer reviewed studies it was highlighted that children in grades 1-3 experienced negative impacts in cognitive abilities due to a lack of education-based support services during COVID-19. These cognitive abilities are directly associated with academic performance and their development was affected by the pandemic (Yates et al., 2025).

Methods and Materials

Design and Analysis

“Lining Up the Fives” is a card game developed by researchers to promote active thinking in young children (Kato et al., 2006). Kamii (2013) stated that this game stimulates children to develop an understanding of numerals while also improving their logico-mathematical thinking. Thus, this study aimed to explore the development of logico-mathematical thinking, utilizing “Lining Up the Fives” for assessing logico-mathematical thinking.

This qualitative case study explored children's logical thinking using “Lining Up the Fives,” a numerical card game. It was completed using a clinical or critical exploration method utilized by Inhelder and Piaget (1964). Duckworth (2005) described how critical exploration involves the investigation of a task by a child while a researcher simultaneously

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explores the child's thinking. Inhelder and Piaget (1964) also demonstrated that the performance of children during a task often provides a better understanding of the nature of their thinking than their actual verbal answers to the researchers' questions. Piaget's critical exploration method allowed the researchers to evaluate children's thinking using a card game as a proxy by observing their actions and asking them why they made a particular choice in each turn to verify the researchers' conclusions about their thinking.

The study was completed using a cross-case analysis (Stake, 2006) to compare multiple individual cases to understand the aggregate data based on the goal of exploring the level of logical thinking in Kuwaiti 6- and 7-year-old children. To begin the analysis the researchers intentionally selected relevant single cases. Then there was a systemic analysis of relevant single cases to enable a rigorous systemic analysis of multiple cases. The researchers selected cases that best displayed the characteristic of logical thinking to explore the similarities and differences across the context to search for pattern as described by Creswell (2009). The researchers carefully analyzed the single case studies and the multiple case analysis which followed as recommended by Stake (2006). The data from each single case included written notes, children's responses, and audiovisual tapes of the children playing a game at two time points. Each case was coded for specific findings which supported categories and clustered according to similarities and differences. Clustered categories with the strongest support were then merged and analyzed for relationship to the theme of the research question leading to the conclusions of the multiple case analysis.

Sample and Procedures

The participants were 19 6- and 7-year-olds enrolled in the New World Institute for Private Training, a private institute that serves parents in Fantas City, Kuwait. Two of the students stopped attending, leaving 17 total participants. After the researchers presented the details of the study the school authorities approved the ethics of this educational research, and only children whose parents returned a written form of consent participated. In addition, the names of the children were changed to ensure anonymity, and only the researchers had access to the video recordings for security purposes. Furthermore, the children

were given the option to withdraw from the study at any time. The materials used in the game were appropriate for young children, with no safety concerns for these ages. The researchers videotaped groups of three children over six weeks in February and March 2023 as they played "Lining Up the Fives." At the beginning of the game, the children were allowed to choose whether they wanted to play and form a group of three. Before playing the game, the researchers ensured that all the children could identify the colors and understand the vocabulary of the game. Each child was videotaped while playing the game multiple times. Approximately three months later, in May 2023, the researchers videotaped the children playing the "Lining Up the Fives" game again.

Research Question

What is the nature of logo-mathematical thinking in 6- and 7-year-old children in Kuwait after the reopening of schools in 2023?

How to play "Lining Up the Fives"

Number of players: Three players are the best for keeping children mentally active.

Materials: Three sets of 10 cards are numbered from 1 to 10 (30 in total). Each set of 10 cards is made using heavy papers in different colors, such as pink, yellow, or blue (see Figure 1).

Rules:

- (1) All the cards are dealt to the three players, and each child places the cards face up in front of himself or herself.
- (2) All players who have fives among their cards put them down in the middle of the table.
- (3) The players are allowed to decide who will be first, second, and third in taking turns.
- (4) During each turn, every player puts down a card individually. The card placed on the table must create a matrix by continuing each line of color to the right or left without skipping any number (for example, six, seven, and eight to the right of the number five card or four, three, two, and one to the left).
- (5) If a player does not have a usable card, he or she must pass, which could be done only thrice. When a player passes the fourth time, he or she is disqualified and must put down all their remaining cards in the

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matrix. It may be necessary to skip one or more numbers in this situation by leaving a blank space in the card sequence.

(6) The first player to use all his or her cards is the winner.

Establishing Credibility and Dependability

The researchers established the credibility of results by utilizing triangulation to cross-check data from two time points, including multiple observations of each child at each time point. Consistent behaviors over time were then determined leading to conclusions of the study. Peer review also added to the credibility of observation results by including cooperating teachers' perspectives concerning the researchers' interpretations. This input first helped to verify the codes used to develop categories and themes while later confirming descriptions of the children's levels of thinking. Member checking also verified the study conclusions. The researchers utilized investigator position as they were the primary instruments of collecting, analyzing, and interpreting the data. This process including reversing the inductive path to conclusions by checking deductively the logic of themes flowing to the coded data.

Results

Regarding the following four examples of children playing card games, the order was generally from a lower to a higher level of logical thinking. The interpretations of the children's thinking were grounded in the critical exploration process, including the researchers' observations, the children's responses to follow-up questions about their strategies, and consultations with classroom teachers. The researchers began with an example at each level, followed by the interpretations.

Example 1: Level 0 Thinking (Reyouf, six years and three months)

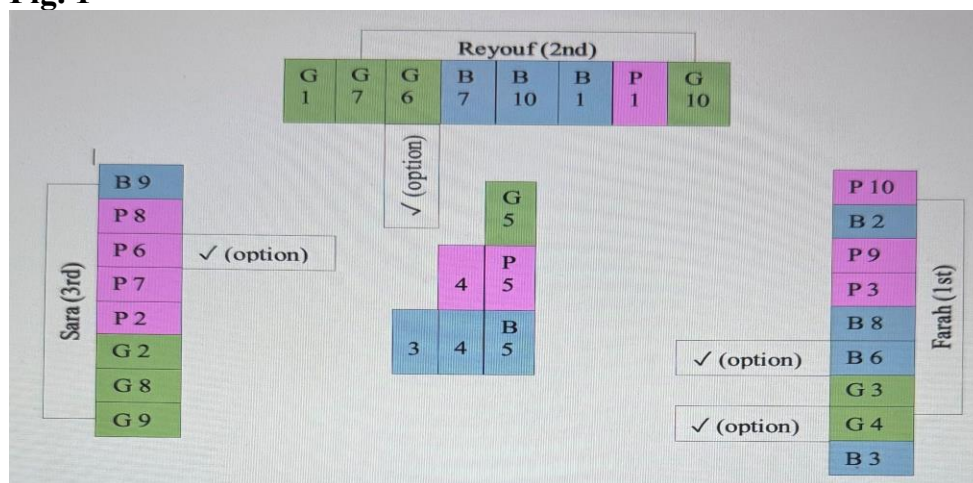
Reyouf was always eager to play. She never completely classified her cards by color or seriate them (see Figure 1) and could not play a usable card in the game or give logical justifications.

Reyouf (first turn): She could only play G6 (see Figure 1). However, she played G7 next to G4, appeared unsure, looked at the researcher, and changed her mind. Thenceforward, she moved the G7 next to the G5. When the researcher asked why she had placed G7 there, she remained silent. Subsequently, she took back the G7 and played G6

beside G4. The researcher asked if G6 belonged there, and Reyouf said, "No." Afterward, she counted her fingers and deliberated. Farah interrupted and said, "If you do not have a card to use, say 'Pass.'" Reyouf responded, "Pass." The researcher asked why she had placed G6 at that location. She silently attempted to count her fingers. Subsequently, the researcher told her that G6 was in the wrong place; thus, she moved G6 next to G5. When the researcher asked why she put it there, Reyouf replied, "Three." The researcher asked for clarification, and she said, "Seven." After the researcher asked her where seven was, she pointed to G5. The researcher inquired, "How much is this (pointing to G5)?" Reyouf counted on her fingers and said, "1, 2, 3, 4, 5, 6, 7, 8, 9, 10." She then recounted from 1 to 10 and said, "10."

Reyouf (second turn): She played B7 next to B3. When the researcher inquired why she picked that card, Reyouf said, "After six, three." The researcher told her that B7 was in the wrong place; she started to pick up G4, which had already been played by another child. Afterward, she changed her mind and placed B7 next to B6. When the researcher asked why she picked up the card, she remained silent. The researcher asked her for the value of the card (B7), and she replied, "Six."

Fig. 1



The players' cards in Example 1

Reyouf was happy to play the game; she was an example of Level 0 thinking. She demonstrated an extremely low level of development in

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five aspects of logical thinking: temporal relationships, categorization, seriation, spatial relationships, and numbers. Although she was always enthusiastic about playing, she was often reminded that it was her turn, indicating a low level of temporal relationship development. Additionally, she showed insufficient categorization and seriation when she failed to categorize her cards by color or seriate them. Further, Reyouf exhibited that she was not thinking about each of her cards' relationships to her other cards. Additionally, she did not compare her cards with those on the table to determine the spatial relationships between them. To illustrate, Reyouf matched the color of the card in the middle of the table, even if it was an incorrect number, demonstrating her limited ability to think of the cards' colors and numbers simultaneously. Consequently, she was unable to provide a reason when she made an error and was either silent or gave illogical answers. For example, when asked about her justification, she replied by singing the numbers from 1 to 10, thus demonstrating that she was just repeating the number order that she had memorized without developing any mental relationships between the numbers. Reyouf's logical thinking was insufficiently developed for her to succeed in this game, leading the researchers to conclude that she was at Level 0.

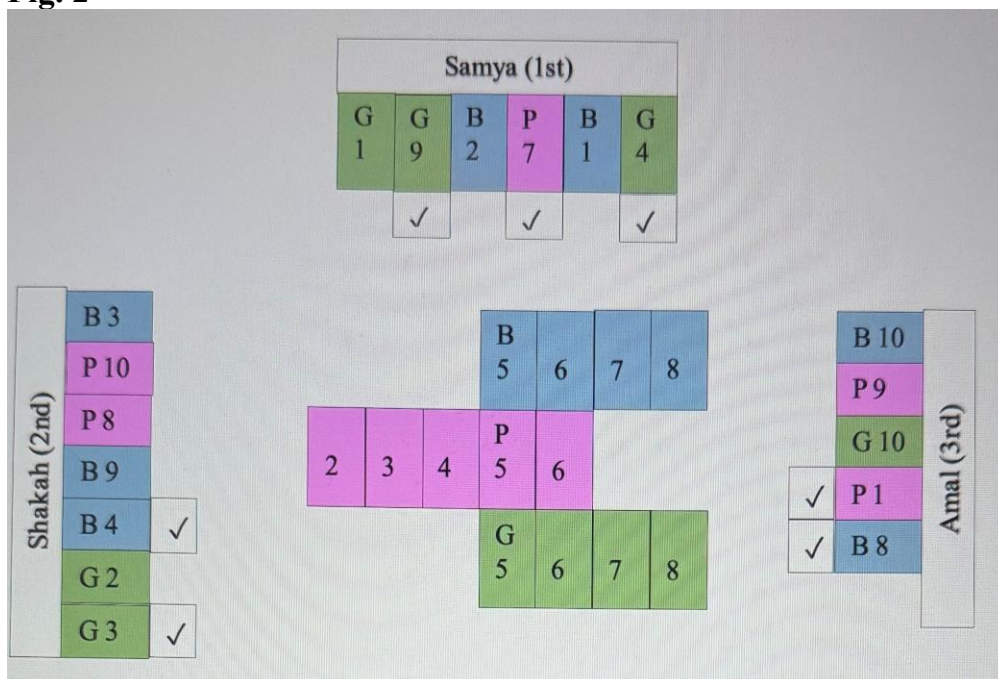
Example 2: Almost Level 1 Thinking (Samya, 6 years and 11 months)

Samya was always excited to play the game. She did not classify her cards by color or seriate them (see Figure 2). She rarely played the correct card or provided logical justifications.

Samya (first turn): She could have played P7, G4, or G9. She incorrectly played P7 next to P2 instead of P6. After the researcher asked her the reason for doing so, she incorrectly played B2 next to B7. After the researcher informed her that it was incorrect, she erroneously placed G9 before G5. On being informed that it was incorrect, she played G4 correctly before G5. When asked by the researcher the reason for doing so, she replied, "After five is four."

Samya (second turn): She incorrectly played B2 next to B5. After the researcher told her that it was incorrect, Samya stared at P7 and then played it next to P6. When the researcher asked for her reason, she replied, "I do not know."

Fig. 2



The players' cards in Example 2

Samya was always excited to play the game and is an example of Level 1 thinking. To illustrate, her logical thinking at times presented behaviors consistent with Level 0 thinking and at other times consistent with Level 1 thinking. She demonstrated an extremely low level of development in the five aspects of logical thinking. For example, she demonstrated behaviors observed in children with Level 0 thinking when she failed to categorize her cards by color or numerical seriation; thus, Samya demonstrated an inability to think about the cards' categorization, seriation, and spatial relationships simultaneously. Furthermore, she did not reveal a firmly established mental representation of numeric seriation when she always relied on counting with her fingers to decide which card to play and whether it was correct. She seemed to have trouble even with lower numbers when the seriation had a large gap, such as in B2-B5. She exhibited an inconsistent justification when she made an error and often said, "I do not know." However, Samya demonstrated a limited numerical seriation ability typical of Level 1 thinking when she displayed the

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correct order in numbers with a small gap like 5-4, including a justification such as “After five is four.” However, she could only use cards that were immediately followed in seriation and had insufficiently developed temporal relationships to think about the future turns. She revealed minimal development in categorization when matching her card color with that of the cards on the table. This inconsistent demonstration of logical thinking led to the researchers’ conclusion that Samya is Almost Level 1 in her thinking.

Example 3: Level 1 Thinking (Yusef, seven years and one month)

Yusef was always pleased to play. He did not classify his cards by color or seriate them (see Figure 3). He correctly played the immediate card in seriation, provided logical justification, and counted forward from 5 to 10.

At the beginning of the game, Yusef said, “We should put them (the cards) together by color.” Each child imitated him and classified the cards according to color; however, he did not seriate them. This was an inconsistent pattern, and in the subsequent games, none of the children classified their cards by color.

Yusef (first turn): He played B9 correctly after B8. When the researcher asked why, he counted, “Five, six, seven, eight, nine.”

Yusef (second turn): He correctly placed B2 after B3. When the researcher asked why, he began to count backwards, “10, 9, 7, 5.” He did not appear to notice that he had left out the numbers 8 and 6. Subsequently, he stopped and began to count forward, “2, 3, 4, 5, 6, 7, 8, 9, 10.”

Yusef (third turn): He correctly placed G4 next to G5. When the researcher asked why, Yusef said, “10, 9, 7, 6, 5, 4.” He did not seem to notice that he had left out the number eight. Further, he did not realize that he had won.

[illegible]

Yusef always enjoyed the game and followed the pattern of Level 1 thinking. His behavior exhibited an improvement over the previous two levels of logical thinking. He revealed the development of temporal and spatial relationships by consistently preparing for his immediate turn, picking the right card in immediate numeric seriation, providing a logical justification for his choice, and seriating up to 10. He demonstrated some development in categorization by matching his card color with that of the cards on the table. However, Yusef demonstrated several limitations to his logical thinking. For example, he classified his cards by color only once and never seriated them. This revealed that he had insufficiently developed categorization, seriation, or spatial relationships to compare his cards with each other. In another example, whenever he tried to seriate backward from 10, he left out several numbers unknowingly. Additionally, he usually seriated up to 10 by starting his count with the number 5 card in the middle, indicating that it was the landmark number that he needed to complete the sequence up to 10. Yusef only picked the right card to play with logical justification when he had the card that was immediately followed in seriation; further, he never showed sufficiently developed temporal relationships to think one or two turns ahead to decide which card was the best to play. He also did not notice that he had won the game when he played his last card, signifying his inability to focus on two aspects simultaneously. Yusef's demonstration of improved

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logical thinking over the previous two levels led to the researchers' conclusion that he had Level 1 thinking.

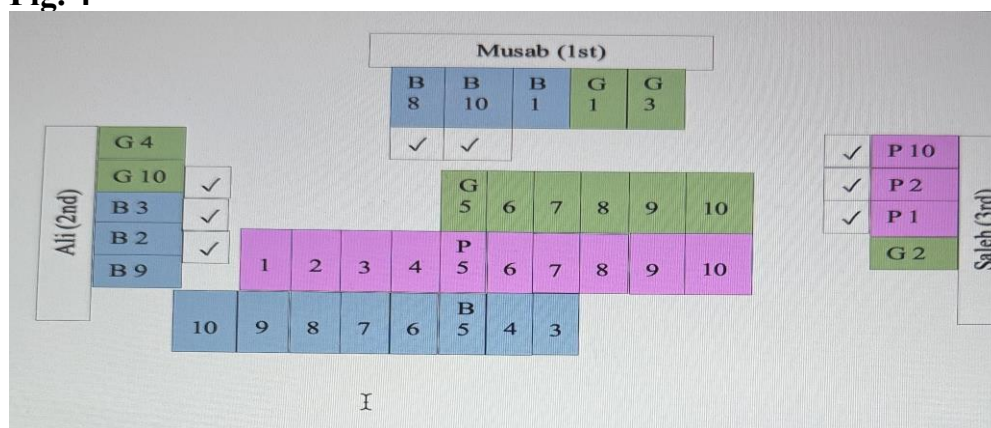
Example 4: Almost Level 2 Thinking (Saleh, seven years and seven months)

Saleh was always happy to play the game. He never classified his cards by color or seriate them (see Figure 4). He correctly played the immediate card in seriation, gave a logical justification, was often prepared beforehand to play his selected card in the next turn, and could count forward in seriation from numbers less than five. He demonstrated his comprehension of each numeral's value on every card.

Saleh (first turn): He did not classify his cards by color or seriate them (see Figure 4). He put P10 after P9 correctly; when the researcher asked his reason for doing so, he pointed to each card as he counted "3, 4, 5, 6, 7, 8, 9, 10." The researcher then asked him to identify several cards to verify his reasoning, and Saleh correctly identified cards P8, P7, and P10. When the researcher asked how he knew each card number, Saleh pointed to a small numeral in the corner of the P9 card.

Saleh (second turn): He already had his P2 card ready to play; however, he switched the P2 and P3 cards in the wrong order. Saleh immediately said, "Wait, wait, wait!" and then moved them in the correct order. Afterward, the researcher asked why he had put it there. He pointed to each card as he counted, "2, 3, 4, 5, 6, 7, 8, 9, 10."

Fig. 4



The players' cards in Example 4

Saleh was always enthusiastic about playing the game and showed improvements over the previous three logical thinking levels. He demonstrated the development of temporal and spatial relationships by consistently being ready for his turn, selecting the right card in immediate seriation, offering logical justification for his answers, and numerically seriating up to ten. Furthermore, when Saleh counted forward, he always began with the lowest card number, unlike the less developed Level 1 thinking players, who began with the landmark number five. Additionally, he demonstrated advanced thinking over previous levels when he corrected his mistakes quickly. He presented the development of categorization when he matched his card color to that of the cards on the table. He also displayed a comprehension of each numeral's value on every card. However, Saleh displayed limitations in his logical thinking when he never categorized his cards by color or seriated them. This indicated that he did not develop mental relationships among his own cards to decide which one was better to play first or to complete his numeric seriation in each color to win the game. He also did not develop mental relationships between his cards and those of the other players to prevent others from winning the game by postponing the playing of some of his cards. Moreover, he displayed limitations in temporal relationships by playing an immediate card and never thinking about the future turns to improve his chances of winning. Saleh's enhanced logical thinking over the previous three levels, with limitations, led the researchers to conclude that he was Almost Level 2 in his thinking.

Example 5: Level 2 Thinking (Ahmad, seven years and five months)

Ahmad was always excited to play the game. He classified all his cards in most games; however, he did not seriate them (see Figure 5). He always played the correct card in series and provided logical justifications. He counted backward with numbers up to five, forwarded up to ten, and thought about his future turns.

Ahmad (first turn): Although he classified all his cards by color, he did not seriate them. He could play B3, P6, or G6. G6 would be the best card to use because he had G8 and G10. He correctly played P6 after P5, which was the second-best choice since he had P7 and P10. When

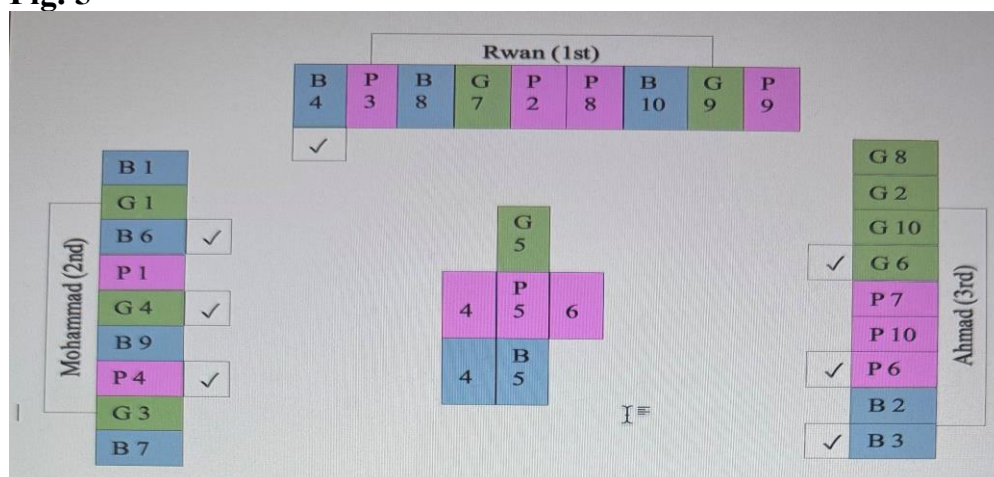
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the researcher asked why he picked that card, he said, "Five, then six. Next time, I will play P7."

Ahmad (second turn): He played the P7 card as planned. When the researcher asked why he selected that card, he said, "I told you I would play this card!"

Ahmad (third turn): He played B3 correctly. When the researcher asked why he had chosen that card, he pointed to the green cards that had been played (five to three) and replied, counting backward, "Five, four, three. Next time, I am going to play B2."

Fig. 5



The players' cards in Example 5

Ahmad always played the game happily and exhibited improvements over all previous levels in logical thinking. He categorized his cards by color in most of his games, demonstrating that he had developed mental relationships among his own cards to determine which one was better for completing the numeric seriation in each color. He also consistently matched his card color with that of the cards already played. Ahmad was able to numerically seriate from 1 to 10 and 5 to 1 by counting forward and backward, respectively. He displayed developments in temporal and spatial relationships by always being ready to play his turn and being able to think about the next one or two turns. Additionally, he consistently played the correct card and provided a logical justification for the card placement. However, Ahmad presented some limitations in the development of the five

aspects of logical thinking. He had insufficiently developed advanced mental relationships in the seriation of his own cards, resulting in him overlooking the future advantages when he had many options to play cards. To illustrate, he could choose the second- or third-best options in many situations; nonetheless, he could not adequately foresee to notice the gaps in seriation between G6, G8, and G10, making playing them earlier the best choice to create the required advantages for winning. He overlooked this choice many times in the game, demonstrating that all five aspects of logical thinking necessary to compare his cards with those of the other players for the best strategy to win were insufficiently developed. The lack of mental relationships was also evident in the absence of blocking the other players from winning the game. Ahmad's improved development in logical thinking compared to the previous four levels led the researchers to conclude that he was at Level 2 in logical thinking.

Discussion

This qualitative case study aimed to explore the logical thinking of five- to seven-year-old children in Kuwait after the reopening of schools following COVID-19 closures. The results of the critical exploration indicated that five distinct levels of logical thinking were observed in six- to seven-year-old children in Kuwait as they played the "Line Up the Fives" card game. As seen in Table 1, their thinking ranged from extremely low to increasingly higher levels.

Table 1

Levels	Number	Percentage	Core behavior
Level 0 Thinking	4	23 %	Absence of categorization, seriation, numeric, spatial and temporal relationship.
Almost Level 1 Thinking	4	23 %	Low level of categorization, seriation, numeric, spatial and temporal relationship.
Level 1 Thinking	6	35 %	Improved level of categorization, seriation, numeric, spatial and temporal relationship.
Almost Level 2 Thinking	2	11 %	Further improvement of categorization, seriation, numeric, spatial and temporal relationship.
Level 2 Thinking	1	5 %	Enhanced development of categorization, seriation, numeric, spatial and temporal relationship.

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As shown in Table 2, the researchers utilized the following coding process to determine the levels of thinking. The codes were merged to identify the coherent patterns of behavior and the theme of Varied Developmental Levels emerged.

Table 2

Code	Category	Theme
Forgets turn, no ability to think of colors and numbers simultaneously, no logical justification for choices, relied on memorized schemes.	Absence of categorization, seriation, numeric, spatial and temporal relationship.	Varied Developmental Levels in Thinking
Limited logical justifications. Counting on fingers, attempt seriation at times, seriates correctly with a small gap in the numbers.	Low level of categorization, seriation, numeric, spatial and temporal relationship.	
Prepared for every turn, seriated forward to 10, and provided reasonable justifications.	Improved level of categorization, seriation, numeric, spatial and temporal relationship.	
Could seriate to 10 from any number, knew the value of written numerals without counting, and corrected mistakes quickly.	Further improvement of categorization, seriation, numeric, spatial and temporal relationship.	
Categorized cards before play began, seriated backward from five, and thought about future turns.	Higher development of categorization, seriation, numeric, spatial and temporal relationship.	

All levels of children were enthusiastic to play “Lining Up the Fives.” Level 0 children had insufficiently developed logical thinking to play card games. They could not think about the color and number of cards simultaneously; further, they could not provide any logical justification for their choices. They relied on the memorized schemes, which were

inappropriate for a successful play. The children who were Almost Level 1 fluctuated between Levels 0 and 1, deliberating as they played the game. Almost Level 1 children had low development in the five aspects of logical thinking to consistently seriate or provide logical justifications for their card choices. They often relied on concrete objects, such as their fingers, to attempt seriation and, at times, could seriate correctly with justification when there was only a small gap in the numbers. Level 1 thinking children demonstrated improved development in the temporal and spatial relationships when they were prepared for every turn, seriated forward to 10, and provided reasonable justifications for their actions in the game. Moreover, Almost Level 2 thinking children showed Further improvement of logical development compared to the previous three levels. They could seriate to 10, starting from numbers lower than the landmark number 5, which Level 1 thinkers struggled with; they knew the value of the written numerals on the cards without counting and corrected their mistakes quickly. The highest level of thinking, Level 2, was characterized by an enhanced development of logical thinking beyond the previous four levels. Level 2 thinkers categorized their cards before the play began, seriated backward from five to one, and thought about the next one or two turns.

The researchers noted similarities and differences between the observations of the children playing “Lining Up the Fives” in Kuwait and those of the children in Japan. One similarity is that the multiple levels of logical thinking of the former corresponded to those of the latter, as indicated by Kamii and Kato (2005). Another similarity is that the lower-level children in both studies played the game haphazardly without systematically examining their cards, thinking only about an immediately usable card. Similarly, the children who demonstrated higher levels of logical thinking in both studies could think about their future turns in the game and systematically examine their cards. Similarly, the researchers’ conclusion supported Kamii and Kato’s (2005) findings that development in one aspect of logical thinking leads to that in the other aspects. For example, when playing the “Lining Up the Fives” game, children need to create classificatory relationships to successfully make actions. They categorize their cards

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into groups by color and, utilizing temporal and spatial relationships, into groups of “the best card to play first,” “the best cards to play later,” and so on. This stimulates them to use numerical seriation to classify cards as “immediately playable,” “cards with a small numerical gap,” “cards with a large numerical gap,” etc. Thus, children with more advanced logical thinking can categorize and engage in superior strategies, such as the ability to block another player and ultimately win the game. Another similarity exists between the Kuwait study and those in Japan and the U.S. Each of these found that the children had multiple developmental levels of logical thinking during the observed activities (Alazemi, 2020; Causey, 2016; Kamii & Kato, 2005).

However, several differences were apparent between the two studies. The first difference between the studies is the cultural setting of Japan as compared to Kuwait and the COVID-19 restrictions on learning during the Kuwait study, which did not affect the former in 2005. The second difference is that Kuwaiti children who had the highest levels of logical thinking were below the Japanese children’s highest levels; moreover, the lowest levels of logical thinking in Japan were higher than those in Kuwait.

Conclusions

The following conclusions are limited due to a small sample. The researchers concluded that Kuwaiti children who faced absenteeism due to school closures and switched to remote learning activities, which were primarily low-level memorization tasks, displayed decreased levels of logical thinking in the game compared with Japanese children; furthermore, the stimulation of the enduring development of logical thinking seems to have been limited. Additionally, the Kuwaiti children aged six to seven years developed the five aspects of logical thinking in sequential patterns, resembling those observed in their Japanese counterparts when they participated in “Lining Up the Fives.”

Implications

There are important implications of this study for educators who desire to stimulate the development of logical thinking in young children. The lower development of logical thinking in Kuwaiti children suggests

that they are more likely to struggle academically when entering elementary school. To achieve academic success, children must have sufficient development in their numerical, classification, serial, temporal, and spatial thinking. This is particularly important for academic success in math and science, which are founded on the development of logical thinking (Kamii & DeVries, 1993; Kato, 2010). In addition, activities such as the card game “Lining Up the Fives” are logical thinking experiences that lead children to think relentlessly and are suggested as better techniques for educators to utilize in stimulating the development of logical thinking (Kamii, 2015a). Moreover, Kamii (2013) highlighted that games similar to “Lining Up the Fives” promote children to develop aspects of their logical thinking, which is the foundation for all future learning (Kamii & DeVries, 1993). Some other examples of activities that teachers could use to stimulate the development of logical thinking include classification and sorting activities in which students group objects based on shared characteristics. Pattern recognition games in which students complete a number sequence by identifying the next number would also be useful. Logic puzzles and riddles which enhance deductive reasoning and problem-solving would be an additional asset to activities.

Limitations and Future Research Directions

This study has several limitations. The first is the boundaries of this study, which include Kuwait, the New World Institute for Private Training, and the time frame for the study. Additional limitations include the age group of 6- and 7-year-olds, a small sample size, and the possibility of researchers bias present in a qualitative study. Future research is recommended for expanding the boundaries of study to public schools in Kuwait, increasing the sample size, exploring other age groups, and focusing on other Arabic countries.

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