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Exploring Student's Computational Thinking in Number Line Patterns through the Dakon Context

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Abstract

This study explores how the traditional game Dakon supports students' computational thinking in understanding number patterns. Computational thinking ability in this study includes four main indicators: decomposition, pattern recognition, abstraction, and algorithm. This study employed a case study design and a qualitative methodology and involved six students in grade VIII of junior high school who were purposively selected based on their level of mathematical ability. Data collection was conducted through observation of Dakon playing activities, number pattern-based written tests, semi-structured interviews as well as records. Data analysis was carried out, with triangulation of data from various sources to increase validity. The findings highlight strengths in decomposition and pattern recognition, while indicating the need for scaffolding in abstraction and algorithmic strategies. This finding confirms that the Dakon game not only strengthens mathematical understanding through a local cultural context, but is also able to build a deep and meaningful foundation of computational thinking. This research recommends the integration of traditional games as part of contextualized and fun math learning strategies to support acquiring skills for the twenty-first century.

Keywords: computational thinking, contextual learning, dakon, number line patterns, traditional games

Abstrak

Penelitian ini bertujuan untuk mengeksplorasi bagaimana permainan tradisional Dakon dapat digunakan sebagai konteks pembelajaran untuk mengembangkan kemampuan berpikir komputasional siswa dalam memahami pola barisan bilangan. Kemampuan berpikir komputasional dalam penelitian ini meliputi empat indikator utama: dekomposisi, pengenalan pola, abstraksi, dan algoritma. Penelitian ini menggunakan pendekatan kualitatif dengan desain studi kasus dan melibatkan enam siswa kelas VIII SMP yang dipilih secara purposif berdasarkan tingkat kemampuan matematikanya. Pengumpulan data dilakukan melalui observasi aktivitas bermain Dakon, tes tertulis berbasis pola bilangan, wawancara semi-terstruktur, dan dokumentasi. Analisis data dilakukan secara tematik, dengan triangulasi data dari berbagai sumber untuk meningkatkan validitas. Hasil penelitian menunjukkan bahwa siswa menunjukkan kemampuan yang menonjol dalam aspek dekomposisi dan pengenalan pola, terutama dalam mengidentifikasi keteraturan distribusi biji dan menjabarkan proses langkah demi langkah secara logis. Namun demikian, pada aspek abstraksi dan algoritma, sebagian siswa masih membutuhkan pendampingan melalui scaffolding dan pembelajaran eksplisit untuk menyusun generalisasi dan strategi sistematis. Temuan ini menegaskan bahwa permainan Dakon tidak hanya memperkuat pemahaman matematis melalui konteks budaya lokal, tetapi juga mampu membangun landasan berpikir komputasional yang mendalam dan bermakna. Penelitian ini merekomendasikan integrasi permainan tradisional sebagai bagian dari strategi pembelajaran matematika yang kontekstual dan menyenangkan untuk mendukung pengembangan keterampilan abad ke-21.

Kata kunci: berpikir komputasional, dakon, pembelajaran kontekstual, permainan tradisional, pola barisan bilangan

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Introduction

In the growing digital era, computational thinking has become one of the essential skills in education, especially in learning mathematics. Computational thinking includes a series of skills such as systematic problem solving, pattern identification, abstraction, and algorithm building that help students in understanding mathematical concepts more deeply (Dia et al., 2024; Helsa & Juandi, 2023;

Apriandi et al., 2023). In recent years, the application of computational thinking in mathematics education has been of increasing interest because it is able to improve student's knowledge regarding abstract concepts more concretely and practically (Del Olmo-Muñoz et al., 2023; Vourletsis & Politis, 2022). Among the mathematical concepts that heavily correspond to computational thinking is the number line pattern. This principle not only teaches periodicity in numbers, but also habituates students to logically and systematically think in predicting patterns and building problem-solving approaches, which are typically learned procedurally without giving students experiences of discovery (Utami & Pramudiani, 2024). Computational thinking helps students to build more effective approaches in acquiring mathematical ideas, like the sequence of arithmetic progressions (Feng et al., 2025; Inayah & Zubaidah, 2020).

Number sequence pattern is one the fundamental concepts in mathematics that plays a significant role in the development of analytical minds among students. The concept helps students understand the pattern of figures; prepares students in systematic and logical reasoning for predicting patterns and establishing problem-solving strategies, which are typically taught procedurally without providing students exploratory experiences, and number relationships that form the basis of many sophisticated math ideas such as algebra and geometry (Junarti et al., 2022). The utilization of number patterns along a number line allows students to see regularities visually, thereby easily identifying and predicting future patterns (Dia et al., 2024; Sarifah et al., 2025). Several studies have shown that the exploration approach can promote students' understanding of number patterns and motivate them to be more critical thinkers in examining number regularities (Apriandi et al., 2023; Dia et al., 2024). But in the process of learning, students are not just told to memorize formulas but neither given an opportunity to identify patterns by themselves. This leaves them with no profound knowledge of the concepts learned. Students, using computational thinking, are able to develop the decomposition skills, pattern identification, abstraction, and algorithms that help organize problem-solving more methodically (Del Olmo-Muñoz et al., 2023; Helsa & Juandi, 2023).

To offer a more realistic and interactive learning environment, several studies have advocated for utilizing games as a platform of learning for mathematics. Aside from providing an interactive learning platform, games also allow students to learn mathematical concepts through first-hand experiences via game mechanisms (Feng et al., 2025; Inayah & Zubaidah, 2020; Kamid et al., 2022). One of the traditional games that can be utilized is Dakon, which has existed traditionally as a strategy and distribution game of numbers. The game involves systematic seed distribution to holes on the board of the game, which requires players to look for patterns, forecast, and come up with the best game strategies. The activity follows the principles of computational thinking, since the students are challenged to notice patterns in seed distribution, identify patterns, and develop algorithm-based strategies at each turn of the game. The use of Dakon game in mathematics learning not only increases the interactive aspect of learning, but also has the ability to increase problem-solving thinking among students in solving number pattern problems (Utami & Pramudiani, 2024).

Notwithstanding the existence of many research studies reporting on computational thinking strengths in the contexts of programming and information technology, research linking it with games in general continues to be limited. Most studies focus more on application in software-based programming, while investigation in the domain of conventional games is limited (Dia et al., 2024; Del Olmo-Muñoz et al., 2023). Although various studies have been conducted on folk games, very few have addressed the interrelation of folk games and computational thinking abilities. This research therefore aims to fill the gap by exploring how the Dakon game can help students develop computational thinking in identifying patterns of number sequences. By associating mathematics learning with traditional games, one hopes that students are able to achieve more contextual and meaningful learning and students are able to better understand abstract mathematical concepts. In addition, learning with Dakon also has the potential to increase student motivation and cultivate a spirit of appreciation for local cultural heritage. Thus, in this study, an attempt will be made to examine the relationship between Dakon games and computational thinking abilities in recognizing number sequence patterns with the ultimate goal of providing new results for culture-oriented mathematics curriculum designing.

Method

This research utilized a qualitative research design utilizing the case study approach. The case study was utilized due to the fact that it aims to grasp profoundly the thinking of the students in an actual scenario, as well as assigning meaning to their engagement within the cultural environment and actual learning exercises. In this case, the context used is the traditional game Dakon as a medium of exploration in understanding the number sequence pattern. The utilization of traditional games in the context of mathematics learning has been proven to be able to build students' computational thinking skills with a meaningful local-based approach (Inayah & Zubaidah, 2020; Jabar et al., 2022). This research focuses on four indicators of computational thinking namely decomposition, pattern recognition, abstraction, and algorithms (Helsa & Juandi, 2023; Apriandi et al., 2023).

This study involved six students in grade VIII of junior high school who were purposively selected to represent diverse levels of mathematical ability. The selection of six subjects was done to obtain in-depth data from each ability level representation (high, medium, and low), where each group was represented by two students. The selection of junior high school as the research location was based on the consideration that students at this level have begun to develop systematic thinking that allows them to apply the concept of computational thinking in games. Junior high school students are at a stage of cognitive development that allows them to be more active in abstract and systematic thinking (Vourletsis & Politis, 2022).

The main instrument in this research is the researcher himself. In qualitative research, the researcher acts as the main implementer who carries out all stages starting from planning, data collection, data analysis, to concluding the results. To support objectivity, several additional instruments were used, namely observation, interviews, written tests, and documentation. Observation was conducted in two forms: participatory and non-participatory. Participatory observation is done when the researcher directly observes student interactions while playing Dakon, while non-participatory observation is done passively to record the thought processes and strategies used by students without direct intervention. These observations aim to capture students' natural engagement and their approach to problem solving in authentic situations (Feng et al., 2025; Kamid et al., 2022).

Interviews were conducted using a semi-structured approach after the play session. The interview aimed to explore students' reflections on the relationship between the Dakon game activity and the concept of number patterns, as well as the exploration of computational thinking elements. The interview guideline was designed based on computational thinking indicators and adjusted the questions if the subject had difficulty answering, to keep the meaning of the students' responses intact (Utami & Pramudiani, 2024). Transcripts of the interviews were written verbatim to be analyzed thematically.

The written test is used to identify the extent to which students can apply the concept of number patterns independently in a non-contextual form. This test consists of description questions designed based on the indicators of number patterns and computational thinking. The use of written questions aims to measure students' explicit ability to recognize, form, and generalize mathematical patterns after involvement in the Dakon game (Jou et al., 2023; Sarifah et al., 2025). The test instrument can be seen in Figure 1 below.

Petunjuk Awal Permainan
Permainan Dakon dimainkan oleh dua pemain (misalnya pemain A dan pemain B). Papan Dakon terdiri dari 14 lubang kecil (7 di sisi masing-masing pemain) dan 2 lubang besar di sisi kanan pemain A dan B sebagai tempat penampungan biji hasil permainan.
Kondisi Awal
1. Semua lubang kecil diisi masing-masing dengan 7 biji dakon, sedangkan kedua lubang besar dalam keadaan kosong.
2. Pemain melakukan suit untuk menentukan giliran pertama. Diasumsikan pemain A mendapat giliran pertama, dan ia memilih lubang nomor 3 di sisinya untuk memulai permainan.

Pertanyaan
a. Jelaskan langkah-langkah yang terjadi saat kamu memindahkan setiap biji dari lubang nomor 3 milik pemain A ke lubang-lubang berikutnya!
b. Jika kita mengganti aturan permainan dakon dengan hanya boleh memindahkan biji dari lubang genap, pola baru apa yang akan muncul dalam permainan? Jelaskan dengan alasan logis!
c. Bagaimana permainan dakon membantumu memahami konsep pola bilangan? Jelaskan dengan contoh pengalamanmu saat bermain!

Game Instructions
The Dakon game is played by two players (e.g. player A and player B). The Dakon board consists of 14 small holes (7 on each player's side) and 2 large holes on the right side of players A and B as a shelter for seeds from the game.
Initial Condition
1. All the small holes are filled with 7 dakon seeds each, while the two large holes are empty.
2. Players make a suit to determine the first turn. Assume player A gets the first turn, and he chooses hole number 3 on his side to start the game.

Question
a. Describe the steps that happen when you move each bean from player A's hole number 3 to the next holes!
b. If we change the rules of the dakon game to only allow moving seeds from even holes, what new patterns will emerge in the game? Explain with logical reasoning!
c. How does playing dakon help you understand the concept of number patterns? Explain with an example of your experience while playing!

Figure 1. Test instrument

Data analysis was conducted thematically in six stages: data collection, data reduction, data presentation, formative conclusion drawing, verification, and final conclusions drawing. Data collected through observations, interviews, and tests were analyzed based on indicators of computational thinking developed in the research framework. Observational and interview data were open coded, then coded into the four indicators of computational thinking. Presentation of information was in story form, by relating the students' responses to the process they followed. Data reduction was done to select the right information and move towards common themes.

To confirm the validity and validity of data, triangulation of sources, methods, and time was employed. Triangulation was done by comparison of observed information, interview information, written test information, and documentation information, and verification of compatibility of findings from these sources. Triangulation strategy was utilized to confirm the credibility and confirmation of outcomes, as outlined in the qualitative process (Del Olmo-Muñoz et al., 2023). The results of the analysis were then linked to computational thinking theory and related previous research in an effort to understand holistically how the students had applied the skills of computational thinking in the context of local.

Student computational thinking evidence in identifying the pattern of the number sequence by using Dakon game can be seen in the following Table 1 (Del Olmo-Muñoz et al., 2023).

Table 1. Indicators of Students' Computational Thinking

Student's Stages of Computational Thinking	Indicator
Decomposition	Able to break down the game process into smaller steps that are logical and comprehensible.

Pattern Recognition	Able to identify and explain the regularity of patterns of Dakon seeds or numbers.
Abstract	Able to construct general rules from observed patterns.
Algorithm	Able to devise systematic steps (strategies) to achieve certain results.

Result and Discussion

The results of an exploration of six VIII grade students involved in learning number patterns through the traditional game Dakon. This research focuses on four indicators of computational thinking, namely decomposition, pattern recognition, abstraction, and algorithm (Del Olmo-Muñoz et al., 2023). Data were collected through observations of play activities, written tests, and semi-structured interviews, then analyzed thematically to identify patterns and trends in students' thinking. The results obtained not only illustrate students' achievements in solving number sequence pattern problems through the context of play, but are also further discussed to reveal the cognitive meaning behind the play strategies they use. The findings are discussed within the framework of computational thinking and culture-based contextual learning, which has been proven effective in bridging students' concrete experiences with formal mathematical concepts (Inayah & Zubaidah, 2020; Kamid et al., 2022).

Decomposition

Decomposition is the ability to decompose a complex problem into smaller parts that are simpler and easier to understand. In the context of the Dakon game, decomposition is seen when students are able to describe the order of distribution of seeds one by one from the starting point to the destination point according to the rules of the game. One of the students who showed excellent decomposition ability was student 2. The following is Figure 2 which displays student 2's written work.

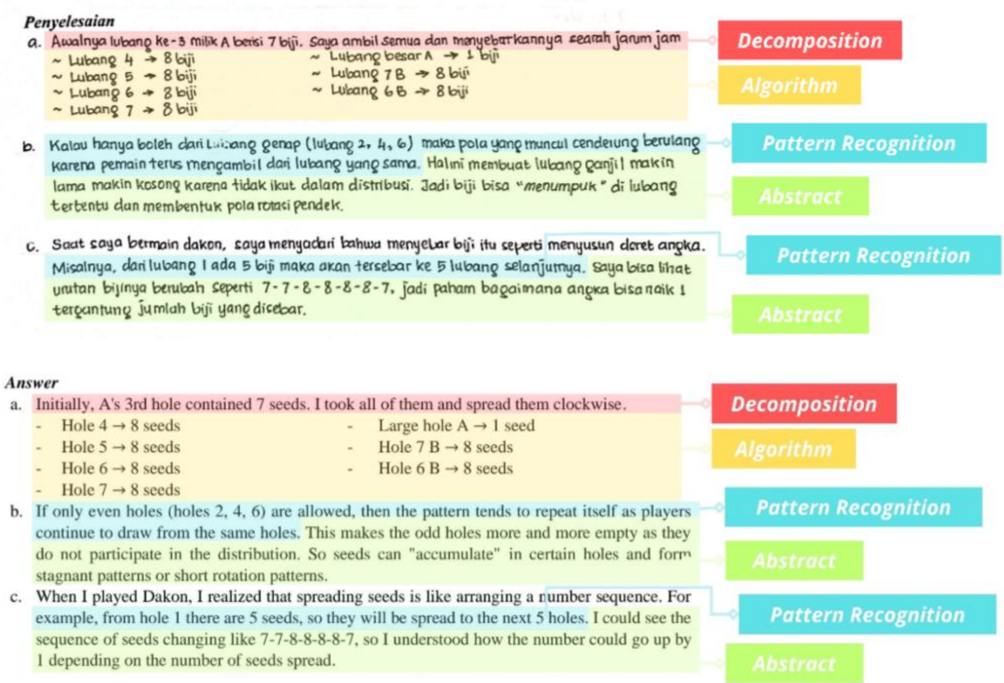

Figure 2. Student 2's work showing the order of distribution from hole number 3

In his answer, student 2 described the distribution of the 7 seeds from hole number 3 to holes 4, 5, 6, 7, the big hole A, and the two player-side holes B. He marked each distribution with arrows and numbers, showing the order in which the seeds moved one by one clearly and systematically. This description indicates that he understands the structure of the game and is able to break down the distribution steps into small, logical and organized parts. This explanation is in line with the student's explanation in student 2's interview.

Researcher	:	*"When playing Dakon, do you find a certain pattern in the movement of the Dakon seeds? Can you explain it?"*
Student 2	:	*"Yes, I saw that if you take a seed from one hole, then each seed adds to the next hole one by one. So, if I take 6 seeds, then the next 6 holes add one."*
Researcher	:	*"How do you strategize your moves when playing Dakon?"*
Student 2	:	*"I pay attention to the seeds that can make my turn continue, so I choose the right number of holes. Sometimes I intentionally make my opponent unable to play."*

The consistency between the written description and the oral explanation shows that students not only understand the distribution step procedurally, but also understand the role of the number of seeds and the direction of distribution in shaping the course of the game. This confirms strong decomposition ability as described by (Apriandi et al., 2023), that decomposition is the initial foundation in the development of students' computational thinking.

Pattern Recognition

Pattern recognition is the ability to identify regularities or repetitions of a process or data. In the Dakon game, this ability is reflected in the way students see the regularity of the number of seeds after the distribution process. Student 6 showed prominent ability in this regard. Figure 3 below shows student 6's written work.

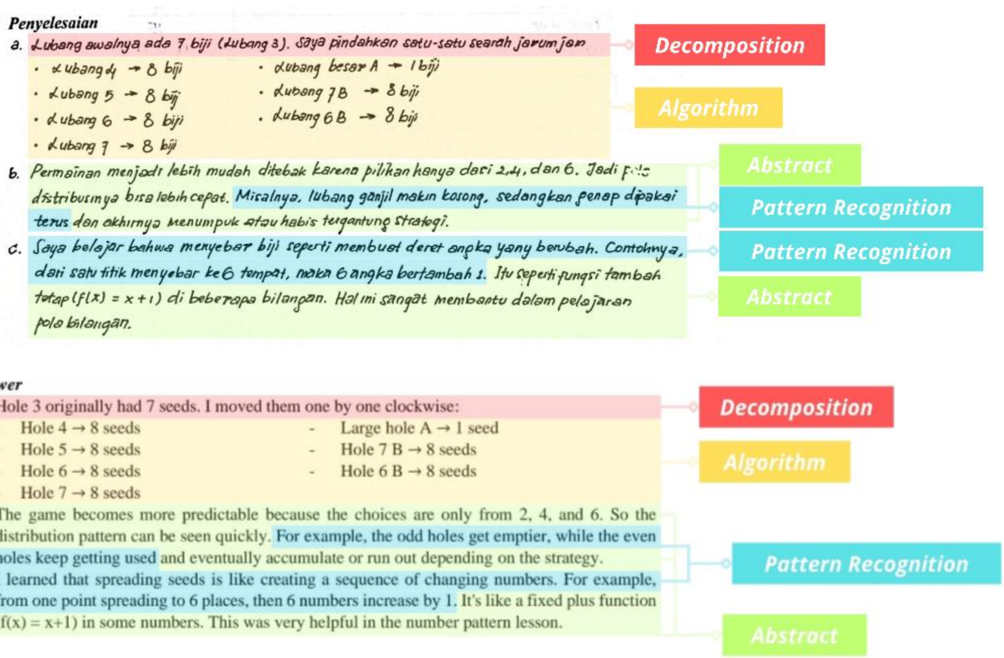

Figure 3. Student 6's work showing the regularity of seed distribution

Student 6 wrote down the results of the seed distribution as a sequence: "7, 8, 8, 8, 8, 8, 7". This means that the 6 holes after the hole taken increased by one seed each. This reflects a repeating pattern of fixed addition, resembling a line of arithmetic numbers. This is reinforced by the following interview with student 6.

Researcher : *"When playing Dakon, do you find a certain pattern in the movement of the Dakon seeds? Can you explain it?"*
Student 6 : *"Yes, I saw that when the seeds were scattered, the holes afterwards would increase by one. It's like a sequence of numbers that goes up slowly."*
Researcher : *"Do you think this game helps in understanding number patterns? Why?"*
Student 6 : *"Yes, because we directly see and experience how numbers can change when seeds are spread."*
Researcher : *"Do you find it easier to understand the concept of number patterns after playing Dakon? Explain your reason!"*
Student 6 : *"Yes, because you can immediately see a real example of how the numbers spread and change their order."*

This student demonstrated the ability to relate the context of the game to familiar mathematical structures. He not only mentioned the result of the distribution, but was able to recognize the regularity and equate it with an arithmetic sequence. This suggests that the Dakon game naturally facilitates the development of deep pattern recognition, in line with which the context of the game can give rise to pattern structures that are easily recognized by students (Dia et al., 2024).

Abstract

Abstraction involves the ability to construct general rules or principles from patterns found. In the Dakon game, abstraction appears when students infer the relationship between the number of seeds taken and the number of holes that will change. Student 4 showed good mastery of this aspect. The following is Figure 4 which displays the generalization compiled by student 4.

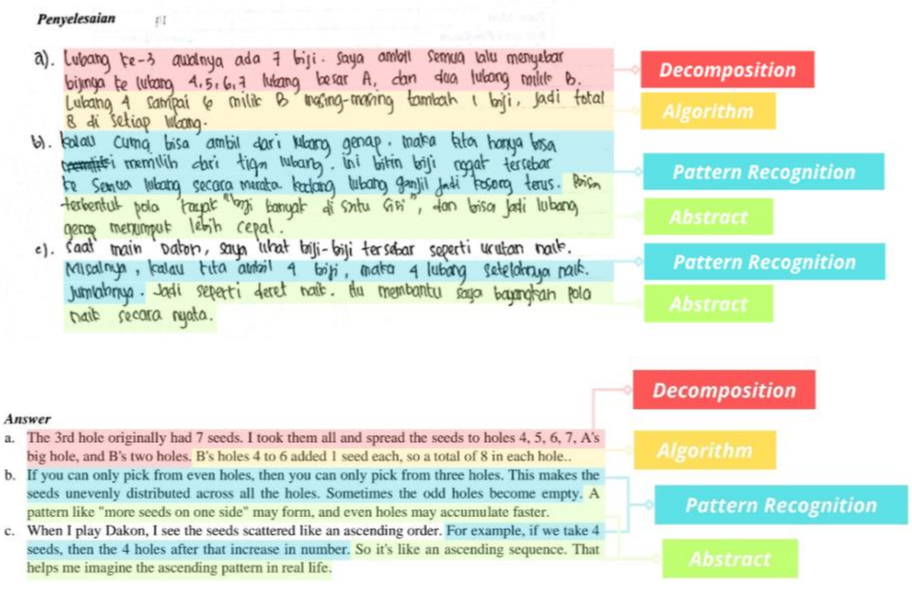

Figure 4. Student work 4 showing the general rule of seed distribution

Student 4 wrote that "if the number of seeds is n, then the next n holes will increase by one." This statement is an explicit form of abstraction of students compiling general rules based on observations of the seed distribution process. With the interview results from student 4 strengthening the following abstraction ability.

Researcher	:	*"When playing Dakon, do you find a certain pattern in the movement of the Dakon seeds? Can you explain it?"*
Student 4	:	*"Yes, when I spread the seeds from one hole, the seeds spread one by one to the holes."*
Researcher	:	*"If you change the rules of the Dakon game, can you find a new pattern?*
Student 4	:	*"You can, for example, if you can only use even holes. The seed pattern will change because the spread is limited and not all holes are used."*
Researcher	:	*"Do you find it easier to understand the concept of number patterns after playing Dakon? Explain your reason!"*
Student 4	:	*"Yes, because I can imagine how the numbers add up from spreading seeds."*

This shows that students not only memorize the process, but are able to construct mathematical generalizations from concrete games. This finding supports the results of research (Del Olmo-Muñoz et al., 2023), which states that students can develop abstraction ability gradually through games rich in repeated structures.

Algorithm

Algorithm is the ability of students to organize systematic steps based on certain goals. In the Dakon game, this can be seen from how students choose holes with a certain number of seeds so that the end result is favorable, for example, so that the last seed falls in its own large hole and gets a turn to play again. Student 5 demonstrated this ability explicitly. Figure 5 below shows student 5's written work.

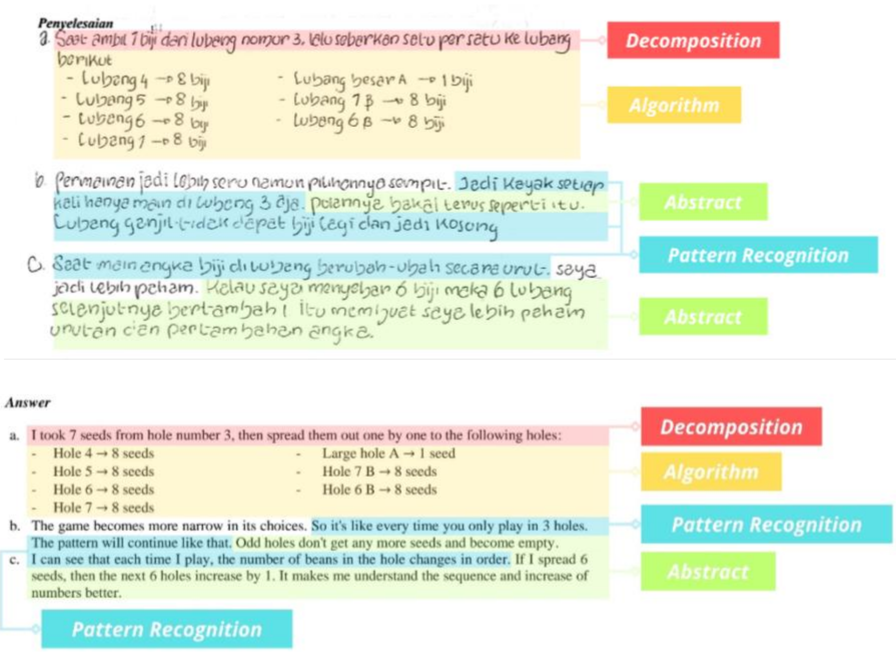

Figure 5. Student 5's work showing the distribution strategy towards the big hole

In his answer, student 5 chose a specific hole with the right number of seeds so that the final distribution fell exactly in his big hole. He consciously calculated and chose the distribution path by considering the final result of the game. The statements in the interview supporting this strategy are as follows.

Researcher	:	*"How do you strategize your moves when playing Dakon?"*
Student 5	:	*"I chose a hole with quite a lot of seeds so that I could spread it far and maybe get another turn to play."*
Researcher	:	*"If you change the rules of the Dakon game, can you find a new pattern?"*
Student 5	:	*"Yes, if the rules are changed, the pattern will be different, especially if you can only choose certain holes."*

This answer shows that students not only understand the distribution steps, but also have goal-oriented thinking. This reflects high algorithmic ability, as explained by (Helsa & Juandi, 2023) that the ability to construct algorithms in a game context encourages students to think systematically and take into account the consequences of each action.

The findings of this study reveal that the traditional Dakon game has a strong potential to foster students' computational thinking (CT) in the context of number line patterns. The four aspects of CT explored in this study decomposition, pattern recognition, abstraction, and algorithm manifested with varying degrees among the six student participants. The most prominent results appeared in the decomposition aspect. Students such as S2 were able to systematically break down the distribution of Dakon seeds, demonstrating a clear understanding of the sequential process involved in gameplay. Decomposition is often the first visible skill in computational thinking when students are presented with structured physical contexts (Apriandi et al., 2023). In Student 2 case, both written work and interview transcripts illustrated his capacity to identify each step and explain the logic behind seed movement. His visualization of the seed flow using arrows and counts reflected an ability to segment a complex scenario into manageable parts. Similarly, the pattern recognition skill was well-demonstrated, particularly by Student 6. He consistently observed that seed distribution created predictable increases in the number of seeds per pit, which he associated with linear patterns. Traditional games are effective in reinforcing pattern recognition through repetition and contextualized experience (Dia et al., 2024). The ability to generalize "each pit increases by one" exemplifies how local cultural games can foster foundational mathematical reasoning.

On the other hand, abstraction and algorithm were less consistently demonstrated. Students like Student 4 attempted to articulate generalized rules, such as "if there are n seeds, then the next n pits are affected." While indicative of emerging abstraction skills, such generalizations often lacked formal notation or clarity, earners at this level often require scaffolding to develop formal generalizations from concrete experiences (Del Olmo-Muñoz et al., 2023). Similarly, algorithmic thinking evident in how students planned steps to reach favorable outcomes was most visible in S5. His strategy to place the last seed into the large pit for repeat turns demonstrates intentional planning. However, not all students demonstrated this level of intentionality, suggesting variability in algorithmic maturity. The interpretation of these findings underscores the role of Dakon as both a cultural and educational tool. The alignment between student actions and computational thinking indicators supports the use of traditional games in mathematics education. Moreover, the findings highlight that contextual, culturally relevant learning experiences promote student engagement and facilitate the development of systematic thinking strategies (Inayah & Zubaidah, 2020; Kamid et al., 2022).

However, the study also acknowledges limitations. First, the small sample size (six students) and single-case design restrict the generalizability of the findings. Second, the reliance on a single game context may not capture the full spectrum of CT capabilities across different learners. Third, although triangulation through interviews, observations, and written work validated data credibility, subjectivity of qualitative analysis may still entail interpretation bias. With these considerations in mind, it is suggested that subsequent research broadens the investigation by including higher numbers of participants in varied school environments. Reflecting on long-term implications of implementing traditional games in mathematics classrooms can also provide valuable insights. Reflecting on computerized adaptations of Dakon can also provide new ways of including local culture and 21st-century learning needs (Feng et al., 2025; Vourletsis & Politis, 2022).

Conclusion

This study concludes that the traditional Halma-like game Dakon has strong potential as a culture-based learning tool for developing students' computational thinking, particularly in number line patterning. The most prominent computational thinking skills demonstrated by students were decomposition and pattern recognition, as they were able to break down game moves and identify consistent numerical patterns in seed distribution. While elements of abstraction and algorithmic thinking were also observed, their development was less consistent, indicating the need for additional instructional support through guided reflection, scaffolding, and classroom discussion to strengthen these higher-level skills.

From an educational perspective, this study highlights that traditional games such as Dakon are not merely cultural activities but can function as effective pedagogical tools in mathematics learning. By embedding instruction within culturally meaningful contexts, students become more engaged, inquisitive, and strategic in solving mathematical problems, while also bridging the gap between concrete experiences and abstract reasoning. Overall, the findings affirm that the development of computational thinking does not require advanced technological resources but can be effectively fostered through grounded, culturally responsive, and reflective learning environments.

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