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Developing and Validating a Tool for Measuring Systems Thinker Habits in Kindergarten Children

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Abstract
This study aims to develop and validate a tool for assessing systems thinker habits in kindergarten children. Methodology: A specialized test was designed, consisting of three distinct activities to assess the systems thinking habits of each child individually. The research sample included 30 children, aged 5-6 years, enrolled in the second level of kindergarten at Al-Agezi Primary School, within the Western Tanta Educational Administration under the Directorate of Education in El-Gharbia Governorate, during the academic year 2023/2024. Psychometric validation of the test was ensured using jurors' validity, Pearson correlation coefficients for internal consistency and test-retest reliability. The findings revealed that the habits most appropriate for systems thinking in kindergarten children include: reciprocal thinking, seeking causal relationships, perseverance for accuracy, considering consequences, appreciating the impact of time, and striving for a holistic understanding of the system. Furthermore, the systems thinker habits test developed for kindergarten children was proven to be a valid and reliable instrument for assessing these cognitive habits. The findings did not show a clear effect of gender on the systems thinker habits of kindergarten children. The study recommends that future studies should expand the application to a larger sample of kindergarten children for generalizability of these results. Educational policymakers and curriculum designers should adopt the Systems Thinker Habits Test, integrating it into early education programs. Additionally, professional development workshops for kindergarten teachers should be developed to train them in nurturing these habits through play-based activities

Keywords: *Systems Thinker Habits, Kindergarten Child*

Introduction

Thinking is a fundamental aspect of daily life. It is a rational approach that influences life plans. When examining children, we find that they experience the world in ways different from adults, as their minds are characterized by inquiry and imagination. Thus, it is essential to carefully observe and evaluate their thinking to provide appropriate guidance (Baron, 2024; Nightingale, 2024).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) identify systems thinking as a key competency. This competency involves analyzing systems, understanding interrelationships, and addressing problems (Grace et al.,2021؛ Kurent & Avsec,2023). Despite the recognized importance of systems thinking as competency is essential for fostering critical thinking and problem-solving from an early age, yet its integration into early education remains limited and there is a notable lack

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of tools and frameworks tailored to assess and nurture systems thinker habits in young children, particularly at the kindergarten level (Al-Ashry, 2017؛ Feriver et al., 2019)

Several researchers, such as Ibrahim (2019), Feriver et al. (2020), and Kaya et al. (2019), have emphasized the importance of focusing on systems thinking in kindergarten children because it contributes to:

- Enhancing their ability to synthesize, analyze, and ultimately create, thus enabling them to understand the world and the relationships between its elements.
- Helping them discover the real causes of problems, leading to optimal solutions.
- Providing them with skills to address future sustainability issues.
- Building their personalities and helping them integrate with society, thus forming a generation capable of effectively engaging with the systems around them.

It is not surprising that the innate foundation for systems thinking diminishes in most children who rely on traditional education. Therefore, one of the significant challenges that have emerged in recent years is the development of a set of essential systems thinker habits that must be emphasized in curricula from the kindergarten stage. These habits help create a cohesive system that encourages seeing the big picture, identifying causal relationships, and considering diverse perspectives, thus enabling children to feel more empowered to tackle problems (Goleman & Senge, 2014).

Al-Sayed, et al (2024) further elaborate that the importance of systems thinker habits lies in their ability to expand thinking horizons, improve problem-solving, enhance decision-making skills, and encourage the retention of information for longer periods, while linking it with other knowledge. Therefore, focusing on these habits in kindergarten children through appropriate programs is essential for producing successful systems thinkers in the future, as intellectual and social capacities begin to emerge during this stage (Al-Ashry, 2017).

Thus, it can be said that effective learning and thinking in the 21st century require attention to the habits of a systems thinker, as these habits emphasize how one thinks and behaves when interacting with systems (Arnold & Wade, 2017). Based on previous references and studies (Al-Samangi et al., 2022; Al-Sayed et al., 2024; Al-Ashry, 2017; Berg et al., 2021; Brangwyn, 2011; Meadows et al., 2016; Waters Center, 2020), 15 habits of a systems thinker were identified, as outlined below:

1. **Observing how elements within systems change over time**: This involves thinking about system interactions and noticing how patterns and trends develop over various time periods.
2. **Striving for a holistic understanding**: Achieving a balance between the larger context and the details, without focusing solely on one part.
3. **Recognizing that system generates behavior**: Seeking actions and connections responsible for producing desired behavior, avoiding the tendency to blame when things go wrong.
4. **Seeking causal relationships**: Identifying the nature of cause-and-effect relationships by observing correlations within the system.
5. **Changing perspectives to enhance understanding**: Attempting to increase understanding by shifting the way aspects of the systemare viewed.
6. **Reciprocal thinking**: Creating meaningful connections within the system by sharing ideas during problem-solving, listening to others, appreciating diverse viewpoints, and seeking the best ideas.
7. **Questioning and testing assumptions**: Improving performance by asking questions and making assumptions about the system, followed by testing those assumptions.
8. **Being deliberate and patient in reaching conclusions**: Resisting the urge to arrive at quick conclusions by exercising patience when facing problems to understand system dynamics before taking action to resolve them.
9. **Recognizing how mental models influence the present and future**: Noticing how beliefs shape the way systems behave in the present and in the future.
10. **Focusing on system structure**: Using the system's structure to identify actions that facilitate better functioning.
11. **Considering consequences**: Taking into account the consequences of actions and decisions on both the short and long term, for both ourselves and others.
12. **Appreciating the impact of time**: Understanding the importance of time by continuously observing how the passage of time exacerbates problems, thus prompting action to resolve them.

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13. **Perseverance for accuracy**: Extracting what is essential and consistently verifying results before adjusting actions if necessary.
14. **Generalizing natural issues and influential relationships**: The ability to generalize relationships occurring in one situation to other situations.
15. **Paying attention to accumulations and rates of change**: Monitoring system inflows, stocks, and information to discern their effects on the system's clarity.

Problem of the Study

Given the importance of systems thinker habits in kindergarten children, and after reviewing previous research and studies (within the limits of the researcher's readings), it was observed that some studies addressed measuring systems thinking skills in kindergarten children, such as the studies of Ibrahim (2019), Ahmed (2020), Hijazi (2014), El-Saeedy (2023), Al-Ashry (2016), Feriver (2021), Feriver et al. (2019), and Feriver et al. (2020).

On the other hand, other studies focused on systems thinker habits across various age groups, such as the study by Al-Ashry (2017), which aimed to raise awareness among kindergarten teachers about systems thinking and its habits in kindergarten children. It recommended that early childhood studies should focus on systems thinking and its habits in kindergarten children, given the scarcity of research in this area, and there is a notable lack of tools and frameworks tailored to assess and nurture these habits in young children, particularly at the kindergarten level.

Other studies, such as those by Al-Samangi et al. (2022) and Ingram & Keshwani (2023), explored systems thinker habits in high school students, while Al-Sayed et al. (2024) examined these habits in primary school students. To the best of the researcher's knowledge, no tool currently exists to measure the level of systems thinker habits in kindergarten children.

Therefore, the current study aims to develop and validate a tool for assessing systems thinker habits in kindergarten children.

Questions of the Study

Based on the aforementioned, the research problem can be articulated through the following questions:

1. Which systems thinker habits are most developmentally appropriate and measurable for kindergarten children?
2. How valid is the systems thinker habits test for kindergarten children?
3. How reliable is the systems thinker habits test for kindergarten children?
4. How much do the systems thinker habits differ among kindergarten children by gender (male and female)?

Objectives of the Study

This study aims to develop and validate a tool for assessing systems thinker habits in kindergarten children, and the following objectives are derived from this aim:

1. To identify the suitable systems thinker habits for kindergarten children.
2. To develop a test for measuring systems thinker habits.
3. To explore gender-based differences in systems thinker habits for kindergarten children.

Significance of the Study

This study derives its significance from being, to the best of the researcher's knowledge, the first study aimed to developing a tool to measure the level of systems thinker habits in kindergarten children.

Terminology of the Study

- **Systems Thinker Habits:** These are the methods most commonly used when thinking or acting while interacting with systems. They are defined as the score a child obtains on the Systems Thinker Habits Test for kindergarten children.

Procedures of the Study

To answer the research questions, the following steps were undertaken:

1. A total of 15 systems thinker habits were extracted based on a review of theoretical frameworks and previous studies (Al-Samangi et al., 2022; Al-Sayed et al., 2024; Al-Ashry, 2017; Berg et al., 2021; Brangwyn, 2011; Meadows et al., 2016; Waters Center, 2020).
2. These habits were presented to a jury of experts to assess their appropriateness for kindergarten children, and the consensus reached is reflected in the habits outlined as: reciprocal thinking, seeking causal relationships, perseverance for accuracy, considering consequences, appreciating the impact of time, and striving for a holistic understanding
3. Design of the Systems Thinker Habits Test as follows:
   - **Test Description:**

   The test is performance-based, consisting of three activities - Playful Shapes, Counting Cubes, and Puzzle Tasks- designed to assess six systems thinker habits. These activities were chosen for their

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alignment with kindergarten-age cognitive and social development. Each activity specifies the tools, time, number of participants, steps for execution, and what the examiner is required to observe for each of the six systems thinker habits. Each child's performance is observed, and their score is determined based on their level in each habit, which constitutes the dimensions of the test. The scoring key is used to evaluate their level.

- **Test Objective:**

The aim of the test is to determine the level of certain systems thinker habits, namely: reciprocal thinking, seeking causal relationships, perseverance for accuracy, considering consequences, appreciating the impact of time, and striving for a holistic understanding

- **Age Group:**

The test is administered to kindergarten children aged 5-6 years.

- **Test Scoring Instructions**

1. After observing the child, their level is recorded in the "Systems Thinker Habits Observation Form" (Form 1) according to the scoring key (*prepared by the researcher*), outlined in Table 1.
2. Each child's score for every habit (dimension) in each of the three activities is rated between 1-4 marks, based on the child's performance level, as follows:
    - The raw score for each dimension (habit) ranges from a minimum of 3 marks to a maximum of 12 marks.
    - The total test score ranges from a minimum of 18 marks to a maximum of 72 marks.
3. A high test score indicates a higher level of systems thinker habits in the child.
4. The Systems Thinker Habits Test was presented to a panel of jurors in its preliminary version, which consisted of three activities and a scoring key. The jurors were specialized in childhood education, psychology, and curriculum development. They were asked to evaluate the appropriateness of the activities in achieving the test's goals and whether they were suitable for kindergarten children. Their suggestions for improvement and modifications were also considered.
5. Administering the test to the research sample, which included 30 children (boys and girls) attending the second level of kindergarten at Al-Ajezy Mixed Elementary School, under the administration of the West Tanta Educational Directorate, affiliated with the Directorate of Education in El-Gharbia Governorate. The children, aged between 5 and 6 years old, were tested during the academic year 2023/2024. The test was administered again after two weeks from the first administration, during the period from October 1, 2023, to October 17, 2023, to verify the psychometric efficiency of the test.
    - Although the sample size was limited to 30 children due to logistical constraints, it aligns with pilot study standards for early test validation (Ibrahim, 2019). Future studies should expand this sample for generalizability.
6. Conducting statistical analyses to obtain the research results.

Discussing the study results and arriving at recommendations

Form 1: Systems Thinker Habits Observation Form for Kindergarten Children (Prepared by the Researcher)

Child's Name (optional): ……

Child's Gender (Male - Female): ……

Age: ……

Date of Test Administration: Day ..... Date ..... / ..... / .....

NO.	Custom	ACTIVITY NAME	Level 1 (1mark)	Level 2 (2 marks).	Level 3 (3marks)	Level 4 (4 marks).	Total
	Reciprocal Thinking	Playful shapes					
		Counting Cubes					
		Puzzle					
	Seeking Causal Relationships	Playful shapes					
		Counting Cubes					
		Puzzle					
	Perseverance For Accuracy	Playful shapes					
		Counting Cubes					
		Puzzle					
	Considering Consequences	Playful shapes					

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NO.	Custom	ACTIVITY NAME	Level 1 (1mark)	Level 2 (2 marks).	Level 3 (3marks)	Level 4 (4 marks).	Total
		Counting Cubes					
		Puzzle					
	Appreciating The Impact Of Time	Playful shapes					
		Counting Cubes					
		Puzzle					
	Striving For Holistic Understanding	Playful shapes					
		Counting Cubes					
		Puzzle					
Test Total							

Form 1: Systems Thinker Habits Observation Form for Kindergarten Children (Prepared by the Researcher)

Table 1: Scoring Rubric for the Systems Thinker Habits Test for Kindergarten Children

NO	Habit	Levels (Grades)			
		1	2	3	4
1.	Reciprocal thinking	He is not interested in communicating with his team, nor does he share his ideas.	He shares his ideas, but does not listen to his team.	He shares his ideas and listens to his team, but without committing to a specific way of speaking (such as raising the hand - idea ball) He tries to cooperate with his team to reach a way to implement what is required in the activity.	He shares his ideas and listens to his team; depending on a specific way of speaking (such as an idea ball, raising a hand). Focuses on selecting the best ideas to implement.
2.	seeking causal relationships	(No causation) It does not explain any causal relationship between cause and effect.	(simple causation) Demonstrates a one-way relationship between one cause and one effect.	(Two-Step Causality) Demonstrates a causal relationship between a cause and an effect only. It shows a causal relationship between a result and only two reasons.	(Multiple causation) It shows a causal relationship between a cause and more than two outcomes (three or more). It shows a causal relationship between a result andmore than two reasons (three or more).
3.	Perseverance For Accuracy	Does not take any action to accomplish the task required.	Takes action to accomplish the task at hand, but does not verify the results of the actions it has performed.	He checks the results of the actions he has taken, points out some errors but does not try to modify them. He is reluctant to identify the tools that are important to him and to rule out error when doing what is required.	Checks the results of the actions he has taken, and modifies the actions if necessary. Identifies the tools that are important to him, and excludes the wrong ones when implementing what is required firmly to achieve the desired results.
4.	Considering Consequences	Does not care about the consequences of the actions.	He avoids only the immediate or future consequences of his various actions.	He avoids the immediate or future consequences of various actions for himself and others. It does not properly classify the consequences of actions as immediate and future.	Avoids both immediate and future consequences of different actions for him or others. Correctly classifies the consequences of actions into immediate and future.
5.	Appreciating The Impact Of Time	Doesn't care about time	Follows the passage of time but does not show keenness to try to complete the task on time.	Shows keenness to try to complete the task on time randomly (i.e. does not divide time between planning and implementation) (Such as urging his colleagues to accomplish what is required before the end of time).	Attempts to complete the task on time with a clear division of time between planning and execution. Note At this level, the child must show a clear sign of time division (such as marking the hourglass with a pen or saying agree in 3 minutes and do the

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NO	Habit	Levels (Grades)			
		1	2	3	4
					rest of the time when using the timer).
6.	Striving For Holistic Understanding	He doesn't care about any part of the system.	One-dimensional perspective: It is concerned with only one part of the system.	Multidimensional partial perspective: It is concerned with one or more parts of the system but has not yet reached all parts or the big picture (total).	A complete multidimensional perspective: His view of the system becomes more comprehensive; that is, the child cares about the big picture of the system along with all its parts (details).

Results of the study

First, results of the first question, stated as:

Which systems thinker habits are most developmentally appropriate and measurable for kindergarten children?

To answer this question, a questionnaire comprising 15 habits was presented to a panel of jurors specializing in the realms of childhood development, psychology, curriculum design, and curriculum and instruction. The objective was to elicit their expert opinions on the appropriateness of these habits are developmentally appropriate and measurable for kindergarten children and to invite them to provide any additional observations they deemed pertinent. The degree of concordance among the jurors was meticulously calculated for each habit, as shown in Table 2.

Table 2 shows the percentages of the agreement of the jurors on the questionnaire of the habits of the system thinker suitable for the kindergarten child N=18

NO.	Habit	Agreement percentage %
1	Understand how mental models affect the present and the future	78%
2	Attention to accumulations and their rates of change	81%
3	Mainstreaming into natural issues and influential relationships	81%
4	Recognize that a system is a structure that generates behavior	85%
5	Attention to system structure	87%
6	Slow down and don't rush to a conclusion	89%
7	Observe how elements within systems change over time	89%
8	Change the situation to increase understanding	89%
9	Questioning and Testing Assumptions	89%
10	seeking causal relationships	91%
11	Considering Consequences	91%
12	Reciprocal thinking	93%
13	Appreciating the Impact of Time	94%
14	Striving for holistic understanding	94%
15	Perseverance for accuracy	94%

N= Number of Jurors *Note: Habits were arranged according to the percentage of agreement between the jurors from the lowest to the highest agreement.

Table 2 presents the findings of the first question, revealing that the jurors reached a consensus on six habits of the system thinker, with an agreement rate exceeding 90%. These six habits are: searching for causal relationships, considering consequences, engaging in mutual thinking, estimating the impact of time, seeking to comprehend the overall picture, and diligence for accuracy. Consequently, the present study focused exclusively on these six habits, as they were deemed the most age-appropriate for kindergarten children. Also the jurors suggesting the simplification of the definitions of the habits of the system thinker suitable for the kindergarten children, as shown in Table (3).

Table 3 shows the habits of the system thinker suitable for the kindergarten children; based on jurors the opinions

NO.	Habit	Operational Definition.
1	Reciprocal thinking	In other words, the child seeks to establish positive connections with his team by sharing ideas while solving problems with others, listening to and appreciating their views, and then searching for the best ideas.
2	seeking causal relationships	In the sense of the child's ability to search for causal links between elements of the system (activity) by linking between one cause and more than one result of it, or one result and more than one cause of it.
3	Perseverance for accuracy	In the sense of the child's tendency to make an effort to reach a solution to a problem, by identifying what is important to him, and trying to verify the results of the actions he has taken and change it if needed.
4	Considering Consequences	In the sense that the child avoids the consequences (immediate and future) that can occur from a certain action by him or others.
5	Appreciating the Impact of Time	This means that the child understands the importance of keeping track of time, and taking the initiative to complete the required tasks, because any time delay will lead to an increase in problems.
6	Striving for holistic understanding	In the sense that the child tries to understand the big picture of the system in all its dimensions, along with its details, and not be limited

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NO.	Habit	Operational Definition.
		to only one part.

Table 3 clearly the amendments were made according to the opinions of the jurors regarding the simplification of the definitions of the habits of the system thinker suitable for the kindergarten children

Second: Results of the second question stated as:
How valid is the systems thinker habits test for kindergarten children?

To answer this question, the study relied on the jurors' validity, in addition to assessing the test internal consistency validity, as outlined below:

A. jurors' validity

The preliminary version of the test, consisting of (3) activities and their corresponding answer key, was presented to a panel of distinguished jurors specializing in the domains of childhood development, psychology, curriculum design, and curriculum and instruction. The purpose was to elicit their views regarding the appropriateness of the activities in achieving the test's objectives, their suitability for kindergarten children, and to provide their insights on potential additions or modifications to the test and its answer key, as they deemed necessary. The percentage of agreement among the jurors for each of the test activities was meticulously calculated, as illustrated in Table 4.

Table 4: Agreement Percentage among jurors on the Activities of the Systems Thinker Habits Test for Kindergarten Children (N=6)

No.	Test Activity	Percentage of Agreement Among Experts
1	Playful Shapes Activity	89%
2	Counting Cubes Activity	94%
3	Puzzle Activity	94%

Note: "N" refers to the number of jurors

Table 4 clearly demonstrates that the jurors reached a consensus on the testing activities, with an agreement percentage exceeding 80%. Moreover, the researcher amended and modified the system thinker habits test of kindergarten children based on the jurors' feedback and suggested modifications, as illustrated in Table 5.

Table 5: Modifications to the Systems Thinker Habits Test Based on Expert Feedback

NO.	Jurors suggestions	After Modification
1	***Adding few instructions to the test as follows:*** • Consider building an atmosphere of familiarity with children. • Taking into account the psychological state of the child; by making sure that he is not exhausted, hungry, sick, or does not have the desire to implement activities. • Warm-up exercises suitable for children. • At the beginning of each activity, explain its steps to children, and clarify its rules accurately, making sure they understand what is required before implementation.	Those instructions have been added.
2	Unify the number of children in all activities.	The number of children has been standardized.
3	Determine the type of participants; children or mothers.	Number of participants: 5
4	Activity 1: Playful shapes — Tools: Use wood sticks instead of matches.	Wooden sticks
	Activity 1: Playful shapes — Modify (if he goes out) to (if he runs) more than one child together in the same role, they go out.....	If more than one child runs together in the same role, they go out .....
5	Interpreting the performance (task) that the examiner is required to observe in the habit of perseverance in order to be more accurate in the activities rather than (observing the performance of the child as a whole during the activity)	The performance (task) that the examiner is required to observe in each activity has been identified.

Table 5 clearly the amendments were made according to the opinions of the jurors regarding of the system thinker habits test of kindergarten children, based on the jurors' feedback

A. Internal Consistency Validity

To assess the internal consistency of the test, it was administered to a sample of 30 kindergarten children enrolled in the second level at Al-Agezi Mixed Elementary School Kindergarten, , under the administration of the West Tanta Educational Directorate, affiliated with the Directorate of Education in El-Gharbia Governorate. Pearson correlation coefficients were calculated to determine the strength of the relationship between each dimension score and the overall test score. The resultant findings are presented in Table 6.

Table 6: Pearson Correlation Coefficients between Overall Test Score and Each Dimension Score (N=30)

No.	Dimension	Pearson Correlation Coefficient with Overall Test Score
1	Reciprocal Thinking	0.555**
2	Seeking Causal Relationships	0.531**
3	Perseverance For accuracy.	0.746**
4	Considering Consequences	0.744**
5	Appreciating the Impact of Time	0.623**
6	Striving for holistic understanding	0.833**

*** * significant at (0.01) N= the number of children in the sample**

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Table 6 clearly the significant Pearson correlation coefficients (ranging from 0.531 to 0.833 at 0.01 level) demonstrate strong internal consistency, validating the robustness of the Systems Thinker Habits Test dimensions

Table 7: Pearson Correlation Coefficients between the Scores of Each Dimension across Different Activities and the Overall Dimension Score (n=30)

NO.	Overall score in all activities for	The correlation coefficient of the degree of the same dimension		
		Activity 1	Activity 2	Activity 3
1.	Reciprocal thinking	0.784**	0.646**	0.709**
2.	seeking causal relationships	0.843**	0.506**	0.774**
3.	Perseverance For accuracy.	0.681**	0.713**	0.740**
4.	Considering Consequences	0.798 **	0.603**	0.771**
5.	Appreciating the Impact of Time	0.804**	0.491**	0. 819**
6.	Striving for holistic understanding	0.817**	0.787**	0. 728**

Table 7 clearly **the significant Pearson correlation between the scores for each dimension across all activities and the overall score for that dimension (ranging from 0.491 to 0.843 at 0.01 level) thus confirming the internal consistency of the systems thinker habits test**

Third: Results of the third question, stated as:
How reliable is the systems thinker habits test for kindergarten children?

To answer this question, the reliability of the test was examined through test-retest reliability, with a two-week interval between the two administrations. Pearson correlation coefficients were calculated between the scores from the first and second administrations. The results are presented in Table 8.

Table 8: Pearson Correlation Coefficients between Test-Retest Scores for the Systems Thinker Habits Test (n=30)

No.	Dimension	Pearson Correlation Coefficient Between Test-Retest Scores
1	Reciprocal Thinking	0.418*
2	Seeking Causal Relationships	0.697**
3	Persistence for Accuracy	0.615**
4	Considering Consequences	0.399*
5	Appreciating Impact of Time	0.426*
6	Striving for a Holistic Understanding	0.389*
	Total Test Score	0.696**

Significant at the 0.05 level. Significant at the 0.01 level. "N" refers to the number of children

Table 8 indicates statistically significant correlations between the first and second test administrations for all dimensions, indicating good test-retest reliability.

Fourth: Results of the fourth question stated as:
How much do the systems thinker habits differ among kindergarten children by gender (male and female)?
To answer this question, the gender (Male and female) -based differences in systems thinker habits among

Table 9: The results of the T-test to indicate the differences between the average scores of the male and female kindergarten children on the Systems Thinker Habits Test. N = (Male =11/ female=19)

No.	Dimension	gender	Mean	Standard Deviation	T-value	Sig.	Decision
1	Reciprocal Thinking	male	3.36	0.80	1.507	0.128	Not significant
		female	3.89	0.93			
2	Seeking Causal Relationships	male	5.09	1.37	1.504	0.144	Not significant
		female	5.78	1.13			
3	Persistence for Accuracy	male	6.09	1.44	0.032	0.975	Not significant
		female	6.10	0.45			
4	Considering Consequences	male	4.00	1.34	1.687	0.103	Not significant
		female	4.68	0.88			
5	Appreciating Impact of Time	male	5.54	1.69	1.706	0.099	Not significant
		female	6.42	1.12			
6	Striving for a Holistic Understanding	male	6.63	1.85	5.16	0.615	Not significant
		female	6.94	0.97			
Test Total		male	30.72	6.40	1.518	0.154	Not significant
		female	33.84	3.02			

N= the number of children in the sample

Table 9 clearly indicates that the T-values are not statistically significant when comparing the average scores of male and female kindergarten children on the Systems Thinker Habits Test and its various dimensions (reciprocal thinking, seeking causal relationships, perseverance for accuracy, considering consequences, appreciating the impact of time, and striving for a holistic understanding). The significance values ranged between (0.099-0.615), all of which are above the significance level of 0.05. This means that there are no statistically significant differences in the average scores of kindergarten children in their Systems Thinker Habits based on gender (male or female).
In light of the analysis, the following results can be summarized:

1. The suitable systems thinker habits for kindergarten children, as agreed upon by the

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jurors include: reciprocal thinking, seeking causal relationships, perseverance for accuracy, considering consequences, appreciating the impact of time, and striving for a holistic understanding

2. The Systems Thinker Habits Test demonstrated both content validity and internal consistency and hence, could be used efficiently to assess Systems Thinker Habits level among kindergarten children.
3. There are no statistically significant differences in the average scores of kindergarten children in their Systems Thinker Habits based on gender (male or female).

Discussion of the results

The results led to the development of a reliable tool to measure systems thinker habits in kindergarten children. The test consists of three activities, designed to assess the level of those habits as previously mentioned.

Strengths of the Systems Thinker Habits Test:

The test provides educators and researchers in early childhood education with a reliable framework for understanding and assessing systems thinker habits. This understanding can guide the development of educational programs and activities that support the development of these habits in children. Future research should explore longitudinal impacts, investigating whether early exposure to these habits influences problem-solving abilities and systems thinking in later education stages.

- The test is practical, requiring simple materials, and can be implemented in any environment, such as a kindergarten classroom or at home.
- To the best of the researcher's knowledge, no previous tool has been developed to measure systems thinker habits in kindergarten children, despite calls for the inclusion of these habits in curricula to enable deeper thinking and problem-solving skills in young children (Goleman & Senge, 2014). This study results aligns with previous studies that measured systems thinking skills in children (Ibrahim, 2019; Ahmed, 2020; Hijazi, 2014; El-Saeedy, 2023; Al-Ashry, 2016; Feriver et al., 2019), though it differs in its focus on systems thinker habits rather than skills.

Despite the strengths of the Systems Thinker Habits Test, it requires multiple examiners to observe the children during the activities. The tasks must be divided among the examiners to ensure precise observation. Additionally, the test demands a high level of concentration from the examiners, as they must assess each child's performance across four levels for each habit.

The present study results are consistent with previous studies on systems thinker habits (Al-Samangi et al., 2022; Al-Sayed et al., 2024; Al-Ashry, 2017; Ingram & Keshwani, 2023), though it differs in focusing on the kindergarten stage, as opposed to older age groups. It support UNESCO's assertion that systems thinking is an essential competency that must be prioritized (Grace et al.,2021؛ Kurent & Avsec,2023).It also agrees with the findings of Al-Ashry (2017) and Feriver et al. (2019), which emphasized the importance of introducing systems thinking from early childhood and the critical need to integrate these habits into early education frameworks which achieves a sustainable approach to education to enhance the capacities of children to become system citizens and responsible capable of tackling societal challenges effectively.

The findings did not show a clear effect of gender on the systems thinker habits of kindergarten children. This may be due to:

- Both sexes are exposed to a huge number of diverse surrounding systems, including various stimuli, which results in a diminishing of the differences between them in the level of Systems Thinker Habits.
- Both sexes are exposed to somewhat similar educational experiences. With the development of modern educational methods, the trend has become towards exposing children to the same activities, programs, and life experiences expressed by adults, especially female teachers, without any discrimination based on the child's gender.
- This result is consistent somewhat with Gezer (2018) who indicated that there was no effect of gender on the systems thinking skills of the kindergarten children.
- It should be noted that future studies should expand the application to a larger sample of kindergarten children for generalizability of this result.

And there is a need for further research using the Systems Thinker Habits Test with a larger sample to precisely determine the predominant level of each habit in kindergarten children. Additionally, future studies could explore how other factors such as intelligence, parental education, and cultural differences impact these habits.

Recommendations of the study

Based on the study findings, the following recommendations are made:

1. Educational policymakers and curriculum designers should adopt the Systems Thinker Habits Test, integrating it into early education programs. Additionally, professional development workshops for kindergarten teachers should be developed to train them in nurturing these habits through play-based activities.
2. Teachers should set aside time each day in the activities provided to kindergarten children to assess and reinforce their systematic thinking habits, which achieves a sustainability approach in education.

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