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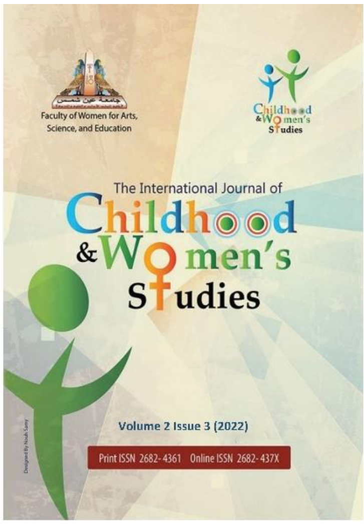

A Program Based on Visual Learning in Teaching Science to Develop some Higher-Order Thinking Skills for Kindergarten Children

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Abstract

This study aims to identify the effectiveness of a visual learning-based program (VLBP) in teaching science to kindergarten children to develop some higher-order thinking skills (HOTS) using the one group pre-experimental design with pre and post-tests for the same study group. The photographed test of the higher-order thinking skills (PTHOTS) was applied to a study group of 18، kindergarten children aging between 6-7 years from one of the public schools in Suez, Egypt. Afterwards, (VLBP) was applied to the same group throughout 15 sessions, covering physical, biological, and geological themes. (PTHOTS) was then re-applied to the same group, and the paired sample T. test revealed significant differences between pre-and post-PTHOTS in favor of the post-test, showing that (VLBP) developed the following (HOTS): arrangement, analysis, reasoning, and problem-solving. These results support the effectiveness of (VLBP), which the researcher recommends being used to enhance (HOTS) in kindergarten children. The findings support integrating visual learning into early childhood science education to foster critical cognitive skills.

Keywords: Visual learning, science education, higher-order thinking skills, kindergarten, early childhood education**.**

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Introduction

In an era of rapid global change, educational systems are increasingly prioritizing the development of critical cognitive skills to prepare young learners for future challenges. Higher-Order Thinking Skills (HOTS) including analysis, evaluation, and problem-solving, are essential for adapting to dynamic environments and making informed decisions. Early childhood is a critical period for cultivating these skills, as research suggests that cognitive abilities such as logical and imaginative thinking begin to develop at a young age (Freeman, 2015; Mahzabin, 2013). National educational initiatives, such as Egypt's "Education 2.0," emphasize the importance of fostering HOTS in early learners to equip them for lifelong learning and global competition (Ghanem, 2018). However, traditional teaching methods often prioritize rote memorization over critical thinking, limiting opportunities for young children to engage in meaningful cognitive development. Science education, in particular, offers a unique platform for fostering HOTS through inquiry-based activities, observation, and experimentation.

Research has also consistently shown a strong connection between (HOTS) and various aspects of cognition and learning. (HOTS) are a set of cognitive abilities that allow individuals to engage in complex problem-solving, critical thinking, metacognition, and decision making (Arif, 2019; Zulharby & YR, 2019; Li et al., 2023). These skills are essential for success in the 21st century, as they enable individuals to adapt to new situations, generate innovative ideas, and make informed decisions (Vidergor, 2018; Alkhatib, 2019).

(HOTS) is grounded in the idea that thinking is a complex process involving multiple levels of cognitive engagement (Pillay et al., 2018). (HOTS) occurs when students gain new knowledge and store it in the memory, then this knowledge correlates with prior knowledge to achieve a particular goal (Abosalem, 2016). Numerous countries have placed (HOTS) as a top educational frameworks' priority (Assaly & Jabarin, 2021; Fensham & Bellocchi, 2013; Ghanizadeh, 2017). Additionally, Malaysia and many countries' national standards for children's education emphasize the need to develop (HOTS), represented in analysis, evaluation, application, and creativity (Suffian & Nachiappan, 2019), as (HOTS) are often used to refer to 'transfer', 'critical thinking' and 'problem solving' (Brookhart, 2010). Research suggests that (HOTS) are associated with improved academic achievement (Widiawati et al., 2018; Larina & Kapuza, 2020), as they enable students to engage more deeply with course material and make connections between different concepts and ideas, (Alkhatib, 2019) as well as give students a wealth of transferable skills (Malik & Setiawan, 2015; Teemant et al., 2016; Baransi & Burbara, 2019). The opportunity to practice (HOTS) in teaching and learning processes makes students more aware of their thinking and enhances their cognitive development (Soleh, 2020). Students with (HOTS) are also able to learn, improve their educational performance, increase their motivation to learn, and reduce their weaknesses (Heong et al., 2011; Widana, 2017; Alkhatib, 2019). When students encounter unfamiliar problems, or any obstacles, (HOTS) is activated, which in turn leads them to create valuable interpretations and decisions.

Educators believe that (HOTS) are those skills that learners exercise when they acquire new knowledge and store them in the memory, so that this knowledge is linked, organized, or evaluated to achieve a specific purpose. These skills include analysis, synthesis, and evaluation, which are the highest levels in Bloom's cognitive classification (Abosalem, 2016). There are also several studies aimed at developing these skills among learners in different stages of education using various teaching methods that proved effective in developing these skills, such as computer-based problem-solving for pre-service teachers (Soleh, 2020) and portable interactive learning media for secondary school students (Dasilva, 2019). Others include a program based on effective teaching for elementary school students (Misykah & Adiansha, 2018), digital games for kindergarten children (Palmer, 2016), the question-and-answer relationship strategy for sixth-grade students (Al-Kafarna, 2015), adaptive learning based on problem-solving for students from grade 7 to secondary school (Raiyn & Tilchin, 2015), and language inputs for parents as a platform for developing (HOTS) for their children in preschool (Freeman, 2015).

Research has shown that implementing (HOTS) in preschool settings can enhance critical thinking, problem-solving, and creativity in young learners (Trzaskowski, 2019; Sutama et al., 2021). It has been observed that applying

(HOTS) elements in preschool teaching and learning processes stimulates structured thinking and focuses on children's cognitive development (Nachiappan et al., 2018; Munar et al., 2022).

By reviewing the previous studies, the researcher found a scarcity of Arabic studies directed at developing (HOTS) for kindergarten children. Most foreign studies followed a descriptive approach in identifying the practices and problems faced by kindergarten teachers in teaching children (HOTS) and indicated that teachers' knowledge of (HOTS) is still limited (Afifah & Retnawati, 2019; Nachiappan et al., 2018; Suffian & Nachiappan, 2019). Therefore, they find it challenging to build and design activities, materials, tools, and appropriate teaching and evaluation methods that improve their practices to develop (HOTS) for kindergarten children, and they recommend providing relevant training courses and designing counseling programs for teachers to achieve this goal.

Some studies also indicate a large gap between the educational goals of developing (HOTS) and the educational practices that children encounter in their educational programs as well as the evaluation methods used to measure these skills (Abosalem, 2016). They also show that the decline in the ability of thinking in children is caused by the learning process that did not motivate children to actively think and find solutions to every challenge they face (Munar et al., 2022). They recommend that children be trained on (HOTS) in early childhood because the education children receive at that stage has a long-term impact on their mental and social development skills afterwards (Suffian & Nachiappan, 2019). Research has also shown that scientific activities are essential educational tools that encourage children to search, investigate, reflect, and practice all thinking skills. Numerous studies have emphasized the necessity of teaching scientific concepts to children, as it is a tool for organizing ideas, discovering, and understanding the elements of the environment (Tannous, 2019).

However, studies have indicated that kindergarten science learning opportunities are ineffective, as many teachers do not teach the targeted science concepts they are expected to teach. Children get fewer opportunities to learn science in the early years compared to other fields, such as literature, social studies, and arts (Saçkes et al., 2013). It was pointed out that 60% of students in Egypt are more likely to memorize during most science and mathematics lessons, and that the percentage of students required to memorize in Egypt is twice the global average (Mullis et al., 2016). Hence, it is necessary to focus on teaching scientific concepts to children through their active sensory experiences and their participation in a variety of activities that suit their potentials, generate motivation and desire to learn, and improve their ability to think, research, and discover, which facilitates understanding of the problems they face in their daily lives (Areljung et al., 2021; Earle, 2022).

Interestingly and attractively, practices like observation, questioning, hypothesis work, classification, comparison, description, interpretation, and understanding of relationships in teaching science to children are all necessary to develop children's scientific concepts and reorganize their cognitive structure meaningfully (López-Banet et al., 2022; Ravanis, 2020). Some studies have indicated that teachers who use visual manipulations to explain and present scientific concepts acquire higher achievement at all educational levels for their students (Boaler et al., 2016), and recent studies demonstrated many international trends emphasizing the importance of visual learning (VL) in achieving national educational goals (Al-Shehri, 2018; Alkalaf, 2020; Gilbert, 2010; Murphy, 2012; Vanichvasin, 2013; Waldrip et al., 2010). Many studies have also indicated the importance of using (VL) as an approach for teaching and learning, as students represent the information visually by themselves then process and link it to the information in their cognitive structure, which strengthens their perception and increases their ability to retain and benefit from it in time of need. It also helps develop visual thinking and links pictures with ideas, words, and concepts (Ibrahim, 2017). Visual Learning (VL) has emerged as a powerful approach in education, leveraging images, diagrams, and other visual stimuli to facilitate understanding and retention. Some studies indicated that (VL) is one of the best methods that help deepen understanding, improve remembering and recalling information (Aisami, 2015), and improve critical thinking skills (Santiago, 2011). Additionally, visually-represented information helps summarize data and enhance teaching and learning processes (Huang & Chiou, 2010), and develop metacognitive skills (Al-Mounir, 2008).

Research has proved the importance of scientific activities and some visual stimuli for enhancing children's (HOTS), where Suleiman (2014) found that using the roundhouse shape strategy developing visual thinking for the second-grade students, and Ghani (2017) reported positive results from using concept maps as an assessment tool in chemistry laboratory activities. Moreover, Al-Enezi (2019) found that using mobile learning developed visual perception among kindergarten children, while Keleman (2021) found that the integration of STEM into project-based learning significantly improved students'(HOTS). Mat et al. (2023) also emphasized the need for a teaching module to promote (HOTS) in primary school science education. Collectively, these studies underscore the value of scientific activities and (VL) in promoting (HOTS) in students.

Despite the importance of (VL), there has been limited research in this field, especially at the kindergarten stage in Egypt. There is a lack of information on planning and implementing activities using (VL) that could develop children's (HOTS), and only few studies have been related to the development of (HOTS) among kindergarten children. Also, while visual cue increases through our children's constant exposure to television channels, video games, computer programs, and the internet, it is difficult to ignore that the generation of children who are now moving through our system didactic is the furthest generation from visual stimulation the system has ever had to teach (Gangwer, 2009; Quiroz Perez & Lema Sananay, 2016). Therefore, the current study addresses this gap by examining the impact of a (VLBP) on developing (HOTS) in kindergarten children.

- **Focus of the Study and Main Hypothesis**

In light of the accumulated knowledge, the study attempts to examine the effectiveness of a (VLBP) in teaching science to develop some (HOTS) among kindergarten children.

The following hypothesis was examined:

There are statistically significant differences between the mean scores of children in the study group in the total (HOTS) and its elements (arrangement, analysis, reasoning, and problem-solving) before and after applying the program in favor of the post application.

This study aims to:

1. Identify key higher-order thinking skills that can be effectively developed in kindergarten children.
2. Design and implement a Visual Learning-Based Program (VLBP) for teaching science to develop these skills.
3. Evaluate the effectiveness of the VLBP in enhancing HOTS among kindergarten children

- **Research Questions**

To achieve these objectives, the study seeks to answer the following questions:

1. What are the appropriate HOTS that can be developed in kindergarten children?
2. How can a VLBP be structured to effectively teach science and develop these skills?
3. What is the effectiveness of the VLBP on children's HOTS?

- **Research Framework**

Higher-order Thinking Skills

Bloom's classification (1956) is the most famous in thinking skills, as he divided them into thinking skills from the lower and higher levels and hierarchically visualized them. He classified the cognitive levels into six categories: knowledge, comprehension, application, analysis, synthesis, and evaluation (Klimova, 2013). The first three levels of Bloom's taxonomy require recognition or recalling, such as knowledge, comprehension, and application, which are considered the lowest level of thinking skills (LOTS). In contrast, the other three levels require students to use higher-level thinking skills and thus improve their educational performance (Saido et al., 2018). The visions and definitions of (HOTS) varied according to the different viewpoints of the researchers. Zohar & Dori (2003) viewed (HOTS) as compiling arguments, asking questions, making comparisons, and solving non-routine problems.

Newman and Schwager (1993) explained that lower-level thinking skills require simple applications and routine steps; in contrast (HOTS) challenges students to interpret, analyze, or process information (Abosalem, 2016). According to Thompson (2008), (HOTS) include solving problems, interpreting information, making complex applications and conceptual understanding, critical thinking, and analysis. Brookhart (2010) summarizes (HOTS) according to the categories defined in the various classifications of thinking into analysis, evaluation and creation, logic and reasoning, issuing a judgment, problem-solving, creativity, and creative thinking. According to Yang (2015), (HOTS) are creative, critical thinking, and problem-solving skills. Freeman (2015) defines (HOTS) as thinking methods that allow learners to expand on a given material, make inferences beyond explicitly presented, construct appropriate representations, and build relationships.

Furthermore, Vidergor (2018) showed that (HOTS) include scientific, creative, and future thinking. Soleh (2020) explained that students who possess (HOTS) can easily access information to use in new contexts, transfer knowledge to different situations, and have the ability to manage, analyze, criticize, and change the acquired information into useful knowledge. Similarly, Budsankom et al. (2015) and Frausel et al. (2020) agreed that (HOTS) is a thinking process consisting of complex procedures based on various skills such as analysis, synthesis, comparison, inference, interpretation, evaluation, and inductive and deductive reasoning, which are used to solve unfamiliar problems.

From the previous presentation, the researcher defines (HOTS) as a purposeful mental activity practiced by kindergarten children when exposed to new knowledge and stimuli as they process information, organize and analyze it, draw logical reasoning and new relationships, and develop proposed solutions to problems. These skills (organizing, analyzing, reasoning, and problem-solving) can be developed in kindergarten children.

Characteristics of Higher-order Thinking skills

All previous definitions confirm the existence of many characteristics of (HOTS) as being non-algorithmic, complex, generative of multiple solutions (involving precise judgments, uncertainty, and appropriate interpretations), reliant on multiple criteria, self-regulative in the thinking process, meaningful in learning, and non-routine in problems that require a great deal of effort from the learner (Al-Kafarna, 2015; Rusliah, 2017; Soleh, 2020; Yen & Halili, 2015).

A range of methods have been proposed for developing (HOTS) in early childhood, particularly in the context of visual stimuli. Alam et al. (2020) and Munar et al. (2022) emphasized the importance of the internet and picture story books, respectively, in enhancing (HOTS). Kenzhebaeva & Kokhanover (2021) presented the "Mind-map" technique as an innovative visual teaching method, while Shalikhah & Nugroho (2023) further suggested the use of various learning models, media, and assessments, such as project-based learning, and STEM. These methods collectively provide a comprehensive approach to developing (HOTS) in early childhood through (VL).

Visual Learning and its Benefits

Visual learning (VL) is a method of processing information represented visually. Numerous studies have shown that 75% of information processed by the brain comes from visual stimuli, and that visual data is better organized in the form of maps in students' minds (Williams, 2009). Therefore, it can be defined as a method of teaching and learning in which ideas, concepts, data, and information are linked to images and technologies, and it is the ability to organize, construct, and give meaning to visual elements (Philominraj et al., 2017). (VL) is presented to learners in several forms, such as diagrams, flowcharts, videos, pictures, symbols, colored books, cartoons, slides, graphs, PowerPoint presentations, and posters (Indrapuri & Perdana, 2022). It helps teachers present a large amount of information in a way that is easy to understand and that helps detect relationships and patterns. According to the current research, the researchers define (VL) as a method of integrating and processing information presented to children through illustrations, symbols, images, and other visual stimuli using different skills, such as observation, perception, interpretation, and self-expression, for the development of some (HOTS) in kindergarten children.

Research on (VL) indicates that our brain is primarily an image processor and that a large part of our sensory cortex is dedicated to vision (Aisami, 2015). Therefore, (VL) helps learners make abstract ideas visible and tangible, link new concepts to previous learning, and provide structures for reflection and discussion, focusing on information and details that lead to understanding and learning. Finally, visuals make learning more permanent and less likely to be forgotten (Murphy, 2012; Rif'at, 2018; Vanichvasin, 2013). Hence, based on the importance of (VL), many studies have focused on using the visual approach in teaching various educational fields, all of which have proven effective in achieving their goals, such as developing mathematical thinking for primary school children (Ibrahim, 2017), improving brain functions (Boaler et al., 2016), developing numerical sense (Ahmed, 2015), developing geometric concepts and spatial sense for primary school children (Hinnawi, 2011), and developing perception and achievement in elementary school children (Dean, 2007).

Studies have indicated that teachers who emphasize the use of visual stimuli to explain scientific concepts acquire higher achievement in their students. Moreover, they stress the importance of visual representation in achieving a deeper and meaningful understanding (Boaler, et al., 2016).

Research has also shown the importance of (VL) in enhancing comprehension and retention, where Hopkins et al. (2019) found a positive association between visual information processing skills and academic performance in Grade 2 students. Makarova (2016) emphasized the effectiveness of visual representation in transforming complex data into easily understandable graphic images, and Vanichvasin (2021) further demonstrated the effects of visual communication on improving memory in undergraduate students. Finally, González-Zamar et al. (2023) highlighted the role of visual arts education in developing visual literacy and promoting critical observation and expressive skills. These studies collectively underscore the significant impact of (VL) on information processing, understanding, and memory recalling.

- **Visual Learning and the Information Processing Theory**

The information processing theory of Atkinson and Schifrin (1968) provide a model to describe the mental processes that take place to transfer information through the short-term memory (which includes sensory memory and working memory), and long-term memory (Aisami, 2015; Lohr, 2008).

Where a child plays an active role in receiving and processing the information when presented with new information through visual stimuli, he performs some mental activities such as attention, perception, repetition, coding, and retrieval by the working memory, as the information he would like to learn is selected from among the information presented through attention then compares that information with previous knowledge to perceive that information in a new meaningful way. The working memory then saves this information in the long-term memory by rearranging and encoding that information to make it easier to retrieve when needed. (Kaya & Akdemir, 2016).

As a result of the studied relevant literature and a theoretical framework, it was found that information processing theory is in line with (VLBP) and teaching science to children as they build their own knowledge and practice cognitive processes, serving as the basis for designing (VLBP).

- **Materials and Methods**

Research Methodology

The study employed a one-group pre-experimental design with pre- and post-tests. The participants included 180 children aged 6 to 7 years, enrolled in the second level of kindergarten (KG2) at a public school in Suez, Egypt. The children were randomly selected from four classrooms, ensuring a representative sample in terms of socio-economic background and gender.

Participants were assessed before and after implementing the (VLBP) to assess changes in their (HOTS). The (PTHOTS) was administered before implementing the (VLBP), then the (VLBP) was applied to the same group. Afterwards, the (PTHOTS) was re-applied, and the difference between the two applications was tested statistically using paired samples (T-test).

This design enables the researchers to understand the impact of the (VLBP) by comparing the results of (HOTS) before and after implementing the (VLBP) within the same group.

Participants

The study group consisted of 4 classes aging between 6-7 years enrolled in the second level of kindergarten (KG2) from a public primary school in Suez, Egypt. Their total number reached 180 children, with an average age of 6.5 and a standard deviation of 0.68.

The classes were randomly selected from a kindergarten school to receive the experimental treatment, where all children in it were of the same socio-economic class and gender representation.

Materials

For the purpose of this study and to answer the first research question, the researcher developed a list of (HOTS) in light of the relevant previous studies. To establish the content validity of the list for this study, a panel of child education professors reviewed each item to ensure the construction of a list that reflected the domains of interest. Suggestions for modifications on some of the items were provided by the panel, and after carrying out the necessary modifications, the panel reported that the list was appropriate for this study. (Appendix A)

Program Design:

To answer the second research question, the researcher designed and developed the (VLBP). The VLBP was developed based on information processing theory, focusing on how visual stimuli engage cognitive processes such as attention, perception, and memory. The program consisted of 15 activities covering physical, biological, and geological themes. Each activity utilized visual aids such as diagrams, images, and videos to facilitate hands-on learning and cognitive engagement.

The program was validated through a panel of experts in child education, and its suitability was confirmed through a pilot study involving 100 children. The activities were designed to encourage arrangement, analysis, reasoning, and problem-solving, aligning with the identified HOTS. (Appendix A)

The idea of the program is based on three main components:

- Inputs: it is the information that the child receives through the visual stimuli which is received by the sensory memory.
- Operations: they include the teaching and learning processes that occur in the classroom, which include the teaching strategies used by the teacher based on (VL) to enhance the various mental activities that a child performs, which aim to develop (HOTS).
- Outputs: This includes the new knowledge that the child retrieves to employ it in solving a problem or doing new tasks.

  The role of the teacher depends on designing and preparing the appropriate visual stimuli for the subjects of the program and grabbing the attention of the children to notice those visual stimuli by asking questions that help them practice various mental processes.

Data Collection and Analysis:

A Photographed Test of Higher-Order Thinking Skills (PTHOTS) was developed and modified by the researcher to measure the target skills. The test included 32 items, combining multiple-choice questions and open-ended tasks requiring children to arrange, analyze, compare, and solve problems.

It was reviewed by the same panel that reviewed the (VLBP) and was applied to the same exploratory sample. The test was applied individually to calculate the stability, validity, and application time. The test's reliability, assessed using Cronbach's alpha, was 0.81, indicating high internal consistency. (Appendix B)

- **Procedures**

Before implementing the original study, the study group teacher was trained to gain a better understanding of the application of the (VLBP) and (PTHOTS).

The pre-test of (PTHOTS) was applied to a study group of 180 children before implementing the (VLBP) then (VLBP) was implemented three days a week for each class at a rate of one activity per day during two periods (each period lasted 30 minutes). The teacher continuously evaluated the activities by asking questions, discussing answers with the children, and providing feedback. Data were collected before and after the implementation of the VLBP. Paired sample t-tests were used to compare pre- and post-test scores, with effect sizes calculated to determine the program's impact.

- **Results**

The results revealed significant improvements in the children's HOTS across all measured domains. Table 1 summarizes the pre- and post-test scores for each skill.

Table 1 Results of paired samples statistics (Pre-test and Post-test) total Score

Skill		Post-test	Pre-test	T	Df	Effect Size (Cohen's d)
Arrangement	Mean	14.730	7.680	47.14***	179	0.92
	SD	1.417	1.626			
Analysis	Mean	14.560	6.860	45.84***	179	0.92
	SD	1.481	1.782			
Reasoning	Mean	9.420	6.190	24.50***	179	0.75
	SD	2.103	1.633			
Problem-Solving	Mean	7.890	5.000	21.72***	179	0.71
	SD	1.790	1.575			
Total	Mean	46.600	25.680	57.35***	179	0.94
	SD	4.205	4.166			

As shown in Table 1, the differences between the pre-test and post-test of the study group revealed statistically significant increase in the mean score of the (HOTS), where the overall (arrangement) pre-test was M =7.680, SD = 1.626, and the post-test was M = 14.730, SD = 1.417, and t = 47.136, df = 179, $p < 0.01$, EESC =0.919. Similarly, the overall (analysis) pre-test was M = 6.860, SD = 1.782, and the post-test was 14.560, SD = 1.481, and t = 45.836, df = 179, $p < 0.01$, EESC =0.915. Also, the overall (reasoning) pre-test was M = 6.190, SD = 1.633, and the post-test was M = 9.420, SD = 2.103, and t = 24.497, df = 179, $p < 0.01$, EESC =0.754. Furthermore, the overall (problem-solving) pre-test was M = 5.000, SD = 1.575, and the post-test was M = 7.890, SD = 1.790, and t = 21.724, df = 179, $p < 0.01$, EESC =0.707. The total (HOTS) pre-test was M =25.680, SD = 4.166, and the post-test was M = 46.600, SD = 4.205, and t = 57.346, df = 179, $p < 0.01$, EESC =0.944. Therefore, the mean score increased after applying the (VLBP) to children, which indicates that the (VLBP) had a significant impact on the development of children's (HOTS). Thus, the main hypothesis of the research is fulfilled.

As shown in figure 1, the findings indicate that the VLBP significantly enhanced the children's HOTS, with the greatest improvements observed in arrangement and analysis. Although reasoning and problem-solving also improved, these skills may require more extended training to achieve comparable gains.

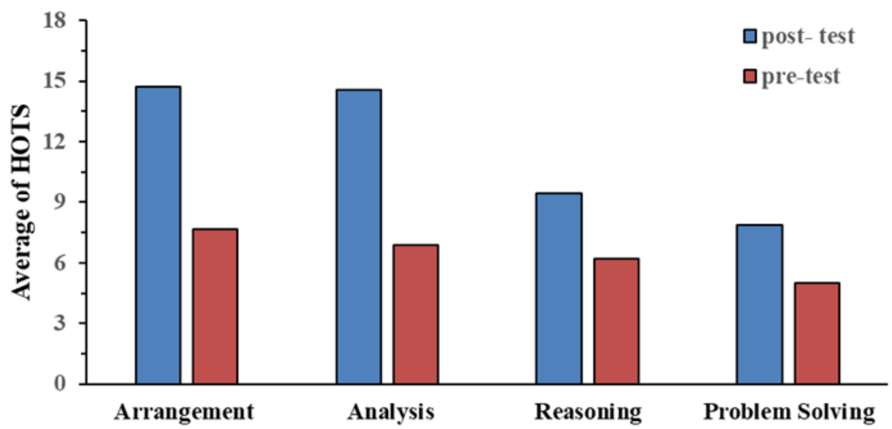

Fig. 1 Differences between the means of the pre and post measurements of (HOTS)

- **Discussion**

The findings of this study are consistent with the previous studies (Freeman, 2015; Palmer, 2016; Alam et al., 2020; Munar et al., 2022) on the promotion of (HOTS) in kindergarten children, which indicate that (VLBP) is successful in increasing some (HOTS). However, the present study has certain advantages when compared with previous research results because it focuses on teaching scientific concepts through (VLBP) with a sample of Egyptian kindergarten children. The present study examined the effectiveness of (VLBP) on developing four subscales of (HOTS); (a) Arrangement, including identifying similarities and differences, and arrangement according to time, size, and length, (b) Analysis, including identifying ideas (main and secondary), and identifying errors, (c) Reasoning, including discovering new relationships and linking causes to results, and (d) Problem solving, including suggesting potential solutions and choosing the best ones. The researchers theorize that these positive results are due to the design of the (VLBP), which allowed children to participate in different types of mental activities.

It was clear from the initial test of (HOTS) that there was a significant decrease in the children's possession of (HOTS). The researchers attribute this decline to the fact that kindergarten teachers give absolute importance to teaching reading, writing, and arithmetic to meet the increasing academic expectations. Also, this finding is consistent with the previous studies, which indicated a lack of teachers' knowledge of (HOTS) and a lack of directing teachers' efforts to develop these skills (Raiyn & Tilchin, 2015; Nachiappan et al., 2018; Afifah & Retnawati, 2019; Suffian & Nachiappan, 2019; Munar et al., 2022). Additionally, teachers have difficulties creating and designing appropriate activities, tools, media, teaching, and assessment methods that develop (HOTS) for kindergarten children.

It was found from the results of the post-test application of the (PTHOTS) that there is a significant increase in (HOTS). The researcher attributes this to teaching science to children through (VLBP) that includes a combination of techniques with multiple types of visual representations in a fun and engaging way based on observation, active sensory experiences, and participation. This is in addition to making children more involved in learning activities, encouraging them to observe, recognize, interpret, perceive, and express themselves, and meaningfully reorganize knowledge into their cognitive structure, which makes knowledge more meaningful and longer-lasting. These findings are consistent with the previous studies of Ravanis (2020), Areljung et al. (2021), Earle (2022), and López-Banet et al. (2022). Moreover, teaching children through (VLBP) in different visual forms characterized by dynamism and attraction made the learning process easier, more interesting, and more exciting for children, and it enhanced their motivation and conceptual understanding. These outcomes are consistent with previous studies by Ritchhart & Perkins (2008), Treagust (2008), Birbili (2013), Mahzabin (2013), Ghani (2017), Saido et al. (2018), Soleh (2020), Keleman (2021), and Mat et al. (2023).

(VLBP) includes some unfamiliar problems and dilemmas that provided children with structural ways of thinking and discussion, which helped them focus on information and details as well as enhanced learning and understanding, and helped them to meaningfully construct knowledge by making connections between prior knowledge and new experiences, retrieving that information, and using it in new learning situations, which is consistent with (Porntaweekul et al., 2015).

The combined approach of teaching thinking implicitly and explicitly within scientific education activities through (VLBP) and raising questions in a way that encourages children to think, discuss, compare, recognize similarities and differences, understand relationships, and solve problems, has led to a complete improvement in such a short time.

The researcher focused on children's assessment of (HOTS), which motivated them to understand the content more deeply and enabled them to not only organize, analyze, infer, and solve problems but to also become more capable of remembering the information that was taught. This result agrees with the findings of Jensen et al. (2014), which emphasized that an assessment focused solely on memorization will not enhance a student's thinking skills, and that promoting (HOTS) among learners makes them more capable of memorizing and retrieving information.

The relatively smaller gains in reasoning and problem-solving suggest that these skills may require more time and targeted interventions. Future research could explore longitudinal implementations of VLBPs to assess their long-term impact on (HOTS). (HOTS) also requires the concerted efforts of all teachers in all educational fields within kindergarten, and this finding is consistent with Misykah & Adiansha's (2018), who indicated that improving students' (HOTS) is a group experience and a collaborative process among teachers of all subjects. It is also worth mentioning that (HOTS) can be taught to all studying levels.

- **Conclusion and Recommendations**

This study demonstrates the potential of visual learning to enhance higher-order thinking skills in kindergarten children. By integrating visual stimuli into science education, educators can foster critical cognitive skills such as arrangement, analysis, reasoning, and problem-solving.

To maximize the benefits of VLBPs, the following recommendations are proposed:

1. Incorporate visual learning strategies into early childhood curricula, particularly in science education.
2. Provide professional development programs for teachers to equip them with the skills needed to design and implement VLBPs.
3. Conduct further research on the long-term effects of VLBPs and their application in diverse educational settings.

By prioritizing HOTS in early education, educators can prepare young learners for a lifetime of critical thinking and problem-solving, equipping them to navigate an increasingly complex world.

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برنامج قائم على التعلم البصرى فى تدريس العلوم لتنمية بعض مهارات التفكير العليا لدى أطفال الروضة

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الملخص:

تهدف هذه الدراسة إلى التعرف على فاعلية برنامج قائم على التعلم البصري في تدريس العلوم لأطفال الروضة لتنمية مهارات التفكير العليا باستخدام تصميم المجموعة التجريبية الواحدة. تم تطبيق الاختبار المصور لمهارات التفكير العليا على مجموعة دراسة مكونة من ١٨٠ طفلاً في الروضة تتراوح أعمارهم بين ٦-٧ سنوات من إحدى المدارس الحكومية بالسويس بمصر. بعد ذلك، تم تطبيق البرنامج على نفس المجموعة على مدار ١٥ جلسة، تغطي الموضوعات الفيزيائية والبيولوجية والجيولوجية. ثم تم إعادة تطبيق الأختبار على نفس المجموعة، وأظهر اختبار(ت) للعينة المرتبطة وجود فروقًا مهمة بين الاختبارين قبل وبعد تطبيق البرنامج لصالح الاختبار البعدي، مما يدل على أن البرنامج طور مهارات التفكير العليا التالية: الترتيب والتحليل والاستدلال وحل المشكلات. وتدعم هذه النتائج فعالية البرنامج الذي توصي الباحثة باستخدامه لتعزيز مهارات التفكير العليا لدى أطفال الروضة.

الكلمات المفتاحية: التعلم البصري، تدريس العلوم، مهارات التفكير العليا، أطفال رياض الأطفال.