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TEACHING NATURAL SCIENCES: SIMPLIFYING SOME PHYSICS CONCEPTS AS ACTIVITIES AND LABORATORY TOOLS FOR KINDERGARTEN CHILDREN

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Abstract. *There is a severe shortcoming in science programs in kindergartens in Saudi Arabia. Therefore, this paper presents a conceptual framework for teaching physics concepts to kindergartens to contribute to the consolidation of scientific knowledge by stimulating the skills of inquiry, problem-solving and scientific thinking among children. The research aimed to study the effect of a program based on simplifying some physics concepts on kindergarten children's knowledge. Data were collected through semi-structured interviews, observation, video recordings of simple lab instruments for physics concepts, and children's in-app interactions and children's photographs. The sample consisted of (8) children of the age groups (5: 6 years) at the third level in kindergarten. The results indicated that children can be taught some scientific thinking skills. Children who practiced the planned activities developed their knowledge more orderly. Accordingly, it is concluded that the program can indicate the success of introducing natural sciences to the kindergarten stage. The current research recommends studies that show the quality and specifications of programs that suit the child's characteristics at this stage and the nature of education.*

Keywords: *Natural sciences, teaching physics concepts, laboratory tools, the focus group method, kindergarten*

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Introduction

Science is an extension of children's everyday world. Science has always been an interesting world for them if presented in the right way. Therefore, it is very important to present scientific concepts following the abilities of children and in an attractive manner, which encourages scientific thinking and nurtures the habits of the scientific mind at an early age. This makes them realize how things work around them. Simplifying physics concepts such as shadow, blowing, rolling, magnetism, electricity, pulleys, etc., and transforming them into simple laboratory experiments will give children knowledge and experience. These experiences and knowledge contribute to the development of scientific thinking and make science an unforgettable educational experience that can inspire and motivate children and make learning more exciting and fun.

When it comes to science education, early childhood educators have a tremendous influence in shaping children's ideas and opinions. Research indicated that by the age of seven, most children have a positive or negative attitude toward science education that remains well established (Shah et al., 2013). Hence, their natural inclinations can be of an advantage early on. During this key developmental stage, a positive approach to science can be nurtured and created to stay with them in the future. In turn, this places an enormous amount of responsibility on early childhood professionals, especially with the global focus on early STEM education (Eshach, 2011; Simoncini & Lasen, 2018). In the current era, science education is not an option for an early childhood teacher. Rather, it is inevitable. The teacher has the opportunity to create exciting experiences that will lastingly affect children throughout their entire educational experience.

To introduce knowledge on physics phenomena to young children, early years learning environments must be supportive of discovery and foster scientific thinking skills. The current research attempts to present a proposal for simple activities on physics concepts that contribute to building foundations for scientific thinking and support the development of children's skills. It has been observed that science activities in educational curricula are very weak.

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Also, the Discovery Corner (science) is just a small table, on which some tools are not employed in real science activities for young people. The time a child spends in this corner is wasted time. With a deep analysis of the educational units in the self-learning curriculum for kindergartens in the Ministry of Education (2016) to find out the percentage of science activities offered to children and the extent of their balance and comprehensiveness of the fields of science mentioned in the Saudi developmental learning standards, it was found that the field of science is weak. The content of (6) educational units was analyzed, each unit containing (15) lessons, in addition to the textbook of brief educational units, which includes (5) sub-units. It was found that the learning units and the summary units did not include any real science activities, and that the activities dealing with science subjects were very few and superficial; they are just titles without real scientific content. Hence, the problem of the current research, which aimed to develop the curriculum presented to children in line with the requirements of the current era, focus on science activities, and try to present them in a simplified form that corresponds to the characteristics of children.

Also, a set of facts collectively formed the problem of the current research. The most important is the kindergarten child's lack of scientific education and opportunities to practice scientific experiences and activities derived from the facts of natural sciences. The current content is focused on language and kinesthetic and art education activities. There is no real interest in science despite the close link between scientific activities and the education of the mind. The content is limited to simple activities such as house sounds, house smells, water and hands, rain, and displaying pictures of some animals and plants. Also, the program does not include any planned scientific activity. They are all activities about using the pen to connect the pictures and find the similarity, and the pictures form only 10% of the content of the educational units.

Given the importance of introducing science early and children's ability to understand it, kindergarten children are evolutionarily able to envision the nature of science when it is taught to them. Researchers recommended the importance of teaching science to children early and explained that children under the age of five can begin to develop appropriate scientific concepts, provided that these ideas are taught through scientific inquiry (Akerson et al., 2011; Jane, 2017). Natural sciences are among the topics that should be introduced early to young children within the school curricula because of their power to develop scientific thinking skills. Given that many studies in this field focus on the stages of introducing concepts, or methods of teaching science teachers, they are rarely directed to kindergarten. Therefore, the current research tried to find a mechanism to simplify scientific concepts in form of simple laboratory activities and tools that correspond to children's cognitive levels. This mechanism may be found acceptable to work with young children. Therefore, the research was keen to describe the methods of simplification in detail and to put links that show a detailed explanation of what the tools and activities should be and were translated into English for teachers to benefit from on an international level.

Research Problem

Teaching physics concepts is of great importance to kindergarten children. They can assimilate them early if presented according to progressive levels of knowledge in the form of tangible activities and tools that they can deal with and engage in field experimentation. Akerson et al. (2011) suggest that kindergarten children are evolutionarily capable of envisioning the nature of science. The researchers made recommendations on the importance of teaching science to young children. The research also showed that children under the age of five can begin to develop appropriate science concepts provided that children are taught these ideas through scientific investigation. This method confirms that these ideas link them to the content taught at those grade levels. Eick and Stewart (2010) indicated that those who trace kindergarten programs will find less interest in basic science experiences. Also, there is a severe shortcoming in science programs in kindergartens in Saudi Arabia. There are neither science books for children nor a guide for the teacher that provides him with a systematic framework to the extent that qualifies him to play the role of an effective and influential mediator in the process of education. The weak presentation of scientific concepts in general and physics in particular in the current kindergarten program led to addressing this problem and presenting a program based on simplifying some physics concepts; a planned program that integrates the cognitive hierarchy of those selected concepts and the children's cognitive levels. Three physics concepts (blowing, rolling, shadow) were simplified as a model for the simplification process according to specific steps: selection and analysis of concepts, concept analysis, the design of simplified laboratory tools, and the construction of gradual-level activities.

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Research Objectives

The current research aimed to

- Examine the current scientific thinking skills of the research sample children.
- Simplify some concepts of physics (blowing, rolling, shadow) in form of cognitively gradual laboratory activities and tools.
- Teach children some scientific concepts of physics (blowing - rolling - shadow) through simplified laboratory activities and tools compatible with their cognitive levels.

Research Questions

The statement of the problem was represented in the following research questions:

1. What are the current scientific thinking skills of children according to each concept?
2. Does children's knowledge of specific scientific concepts change if introduced during a planned program?

Theoretical Background

Natural Sciences and their Learning in Early Childhood Classrooms

Teaching natural sciences requires an educational system that allows children to explore, investigate, observe, question, and inquire about facts and information about all phenomena on the one hand. Also, it requires opportunities to form and use the concept in different situations, enabling them to test the concept and make appropriate modifications to it on the other hand. Teaching science in exploratory ways makes the knowledge acquired by children last longer. When a child faces a situation that challenges his thinking, he seeks to use the skills of science and reorganizes his knowledge to enable him to discover the concept. In turn, this will increase his motivation to learn and reinforce the concepts he has previously learned.

The natural sciences, including physics, are a prerequisite for knowledge (Azuma & Nagao, 2008). Physics is an important subject that everyone should learn. Parents and teachers are responsible for children's learning of physics. Therefore, early learning of physics is essential (Nasrudin et al., 2021). Most things and technology in our daily lives are governed by basic physics principles. When these principles are understood, the world can be understood (Bloomfield, 2015). According to Piaget, a child knows his world by coming into contact with objects in his environment. Then, he begins to form complex ways of thinking about the elements of the world. Here, the child himself interacts with the things, people, and events around him. At every moment, he acquires information and tests and corrects his ideas. Physics experiments will nurture mental development through exciting exploratory situations (Kandil & Donia, 2000).

Physics knowledge activities are those in which children experience and discover how things work in the physics world. In these activities, children work on objects to produce desired effects and observe reactions to objects (Kamii & DeVries, 1993). According to Qandil and Donia (2003), the experiment is one of the best methods of research. The child, under the guidance of the teacher, can crystallize and form hypotheses and suggest ways and solutions to examine these hypotheses without realizing that these assumptions in the strict sense are only guesses. According to Badawi (2016), project-based learning is effective in imparting scientific concepts. It is recommended the necessity of training kindergarten teachers on how to develop scientific inquiry skills, form scientific concepts for children through project-based learning, and take into account integration when planning and implementing kindergarten programs. However, most teachers in kindergarten still use less effective methods, and the reason behind this is that teachers feel that they are not well educated in the field of science (Ahmed, 2017).

The idea of physics knowledge activities is rooted in Piaget's constructivist theory. Research by Piaget and colleagues shows that developing the ability to think is essential to building knowledge in young children. They distinguished between three types of knowledge: social, physics, and logical-mathematical. Physics knowledge refers to the properties of objects, such as color or texture (Kamii, 2000). According to Kato and Meeteren (2008), physics activities are appropriate for young children because they can come up with their ideas about things and test these ideas in the real world. The most important aspect of physics knowledge activities is the possibility of failure rather than success by trying to discern the discrepancy between the expected and actual results. As emphasized

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by Piaget (1973), children need to make mistakes to reach the truth. Allowing children to develop problem-solving strategies based on their mistakes empowers them as learners. Mistakes are not viewed as a negative experience. Rather, they are a sign that something is not quite right, revealing an exciting challenge to overcome. When a problem contradicts a child's belief about how the world works, he has an inner need to understand and change what is going on. Children think carefully about what they already know, reconsider their understanding of how the world works, and use many strategies to solve the problem (Kato & Meeteren, 2008).

Nasrudin et al. (2021) confirmed that with the right approaches, methods, and media, the learning provided by the teacher will make children more familiar with physics. The research concludes that physics can be taught in early childhood. Therefore, it is recommended that early childhood teachers collaborate with physics teachers in planning, implementing, and evaluating physics learning.

Concepts not only efficiently organize information in memory but also support other cognitive functions. These functions include identifying objects in their world, forming analogies, making inferences that extend knowledge beyond what is known, and finding connections between the central elements of theory. These pivotal tasks appear in later stages. However, the structural foundations for it must be available in the early stages of life. Hence, the value of the interest in introducing concepts in early childhood has emerged. Some recent studies pointed out the importance of forming the scientific concept in the learner's mental structure because the concept often settles in the learner's long-term memory, which earns him long retention of the scientific material (Al-Muhaisin, 2007; Kandil & Donia, 2000). Scientific concepts are one of the most important aspects of science learning because of their importance in organizing experience, remembering knowledge, following up on perceptions, linking them to their sources, and facilitating access to them (Khataiba, 2005).

Research Methodology

Design

The current research adopted an explanatory perspective and a qualitative approach to simplify some physics concepts in the form of laboratory activities and tools to teach children about physics within the ability of their cognitive levels. The qualitative approach is a flexible scientific approach that relies on multiple methods of collecting non-numerical data. All of which are suitable for working with children. Therefore, the study adopted the focus group method, one of the common qualitative research methods used in data collection. It was chosen to answer questions such as "How, what, why, and what would happen if....". According to Krueger (2014), a focus group is used to explore perceptions, ideas, problem solutions, and interpretations concerning knowledge, understanding, and mitigation of physics. Semi-structured interviews were also used to ensure a spontaneous interaction between the researcher and the participants. It includes a set of closed and open questions structured, so it is also suitable for youngsters (Tenenbaum & Driscoll, 2005). The interview was semi-structured, characterized by deep or open questions and relies on dialogue to understand the participants' behaviors and way of thinking, without putting any projections to limit the answers given by the respondents (Al-Dhahyan, 2012).

Population and Sample

The study population consisted of third-level children in kindergarten schools in the Kingdom of Saudi Arabia. The study sample was selected using the purposeful sampling technique that suits the qualitative research. It was conducted at Third Early Childhood School in Al-Hofuf, Saudi Arabia from February 2022 to May 2022. Eight children (3 females, 5 males) were selected from one grade of the third-level Kindergarten which included children from the age groups (5:6) years. Those children who attended permanently and whose parents agreed to allow sitting with the children for long periods, even after the official working hours, were selected. Also, the research followed the qualitative method based on small samples. Samples in qualitative research are usually smaller compared to those in quantitative research. In addition, it is worth noting that samples of small size may be of great benefit than those of large size in some studies, especially those studies requiring observations and interviews (Ghobari et al., 2015).

Several steps were taken since the beginning of the research idea:

- It was confirmed that the research idea is not a duplicate of previous studies, but an addition.
- The tools were designed from safe materials for children (cardboard).
- The data were collected following the qualitative approach (semi-structured interviews, observation,

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video recording, and analysis of children's responses). The researchers reviewed the data separately, then matched, discussed, calculated agreement among them, and excluded the points of difference while maintaining the data confidentiality.

- The approval of the school in which the application was carried out was obtained. Children were photographed in a way that does not show their faces, and the children's data were kept confidential.
- The parents of the children were contacted to obtain approvals on the application, allow them to spend more time with the children, and explain what is required of them accurately.
- This research is funded by King Faisal University in the Kingdom of Saudi Arabia; therefore, all research steps are subject to supervision by the Deanship.

Instruments

1.Diagnostic Tests

Three tests were designed to diagnose the cognitive output and the ability to employ some science operations for each concept (blowing, shadow, rolling). These tests aimed to diagnose children's knowledge of the presented concepts and their ability to practice some science operations. The test items were built by developing questions related to each concept and determining the skill related to the practice of science operations related to it.

Table 1
Science Processes and the Nature of the Questions Presented

Process	Questions
Awareness: Recognizing the properties of objects, attention, recall and perception.	Describe what you see, what you notice, what happens first? Have you seen this before? Where?
Exploration: understanding the elements of the situation, gaining more information, collecting data, and knowing the relationship between the elements of the situation.	What are you doing for you...? Why does it happen...? What is the difference between...? Questions on length, shape, volume, weight, and degree of friction.
Inquiry: deepening understanding, attention, and understanding of experience.	Questions that require more understanding and attention to be answered: What happens if..? If it happens...? Does it happen...? What are you thinking about...? What is the difference between...? It includes conducting experiments.
Performance: Employing knowledge in new situations and using it to solve simple problems.	Why? Is it possible? How can it work...? What can be done with...?

2. Designing the Physics Program According to the Following Steps:

a) The stage of selecting and analyzing physics concepts: Three physics concepts were identified (blowing, rolling, and shadow), and they were selected according to several criteria:
   - Topics related to the environment and daily life that fall within the interests and questions of the child.

b) The possibility of converting them from the abstract image to the physical image: These criteria were derived from previous studies and developmental learning standards in the Kingdom of Saudi Arabia (Ministry of Education, 2015). Each scientific concept was analyzed into five levels, each of which carried a scientific idea on which the following idea was built. Then, it was transformed into gradual level scientific activities, commensurate with the characteristics and capabilities of the child. Finally, performance was assessed during practical situations that the child performed during the activities.

3. Steps to Analyze the Physics Concepts (the Topic of Research):

The analysis of physics concepts and the construction of their activities relied on several sources (American Association for the Advancement of Science, 1993; Kandil & Donia, 2000, 2003, 2006). The program was designed according to specific steps:

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a) Scientific principles related to each concept.
b) An introduction to learning each concept for children.
c) Some diagnostic procedures for each concept (Appendix A).
d) Designing five activities for each concept (blowing, rolling, shadow) gradually and include: the name of the activity, the practical idea involved in the activity, the procedural objectives of the activity, the tools used, the activity procedures with children, suggested questions about the concept, and the experimental situation controls. A sample activity for one of each concept was presented (Appendix A).
e) Photographing the design steps and the method of presenting activities and interacting with children. Links were attached showing the design steps to serve as a guide for those dealing with children (Appendix A).

4. Links to Simplified Tools:

- -Blowing (https://www.youtube.com/watch?v=2Q2h0sNgMIl&t=1s)
- -Rolling (https://www.youtube.com/watch?v=BriHvmAg9TM
  https://www.youtube.com/watch?v=jjgLjCwvGO0
  https://www.youtube.com/watch?v=fNHw50iBzl0
- Shadow (https://www.youtube.com/watch?v=tBJ11O6Dvfs)

5. Simplified Laboratory Tools for physics concepts:

Figure 1
Simple Lab Tools for the Concept of Blowing

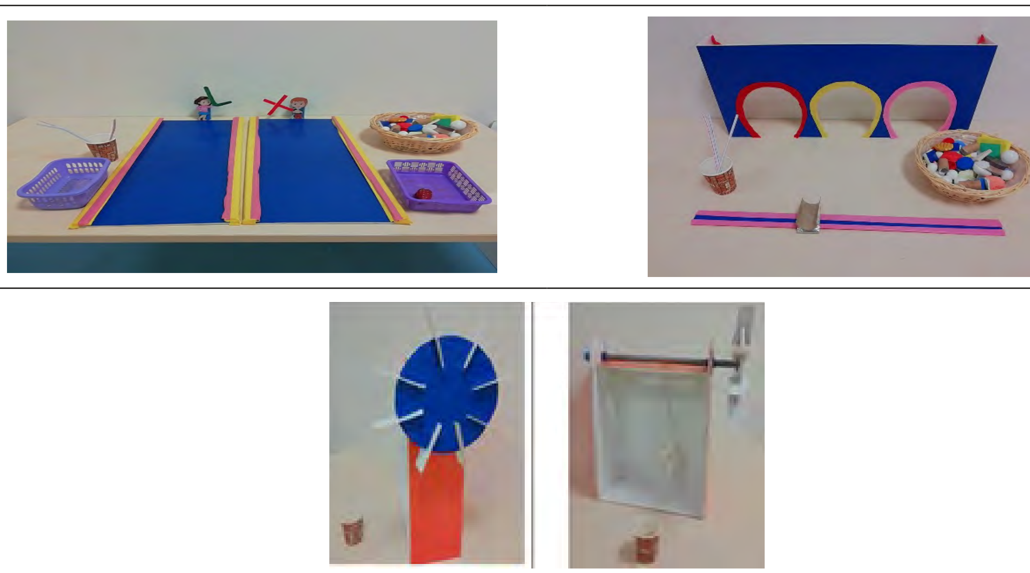

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Figure 2
Simple Lab Tools for Rolling Concept

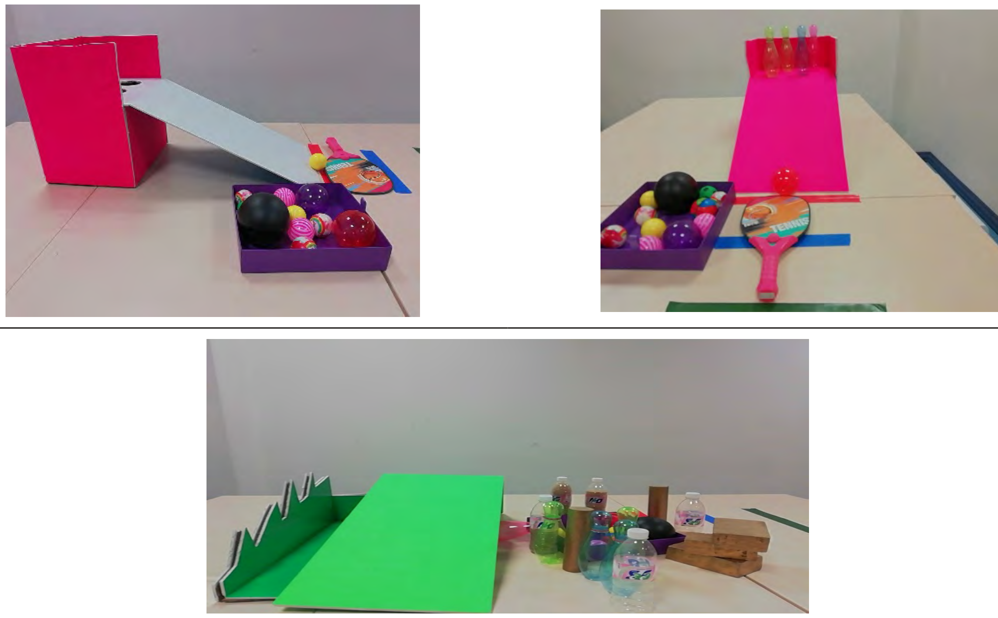
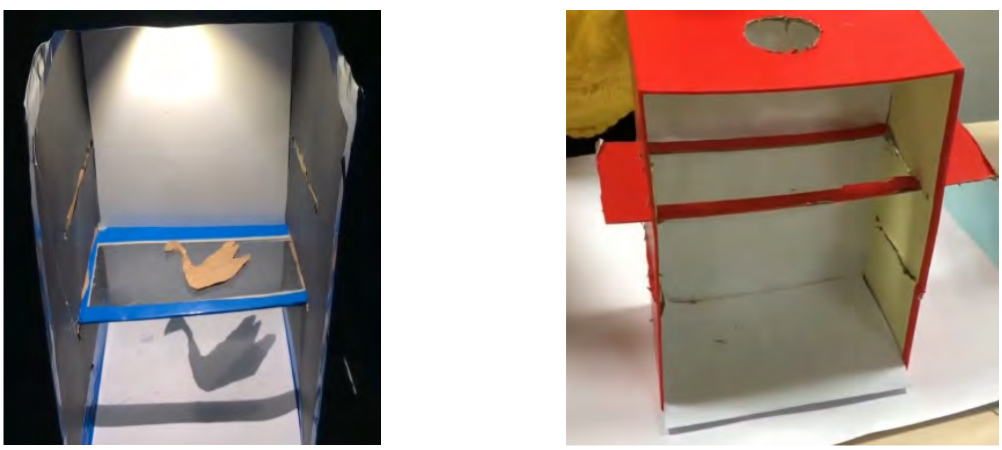


Figure 3
Simple Lab Tools for Shadow Concept



a) Scientific principles related to each concept

-Blowing

1. Air movement is a force that has magnitude and direction and can be employed.
2. The distance that the body leaves under the influence of a force depends on the amount of that force acting, and the amount of friction or impediment to the movement that the body encounters during its movement.
3. Objects with large masses are weakly affected by the force of air in relation to objects with less mass.
4. A n object moving on a rough surface moves with more difficulty than it does on a smooth surface.

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5. Energy can be converted from one form to another.

-Rolling

- Energy of motion: the amount of work done during the movement of the body, that is, if a body moves, it does work to overcome the resistance that it encounters until it rests.
- Potential energy: depends on the relative position of the body, when work is done on it, it is converted into kinetic energy.

-Shadow

- Light travels through wave motion. It propagates in spherical waves, the center of which is the light source, which propagates in all directions. The direction of light waves can be represented by a line called the light ray, which is a line that represents the direction of light travel.
- Light is scattered in the center in straight directions. The path of light from its source to a point in the center surrounding a straight line can be represented by a straight line called the light ray.
- The spread of light in straight lines creates shadow. If a dark obstacle is placed in the path of the light emitted by a light source, this obstacle will form a shadow.

b) An introduction to learning each concept for children

Before presenting any scientific concept, the teacher should read carefully about the concept to be presented to the children, so that she can present it in a simple way to the children and answer their questions in a scientifically correct manner in line with their mental abilities. The current research tried to provide scientific information for each concept to form a scientific base for the teacher from which to start.

-Blowing

1- Blowing air through the mouth is only a simple embodiment of the force of the air to realize its effect on the movement of mass and the movement of things.
2- Most children make mistakes for reasons related to breathing habits (inhale and exhale) or for health reasons. Therefore, first, we have to train the kids how to breathe properly.
3- Put this tube in your mouth. Can you try what we did before and get the air out of your mouth through the tube? You can try now.
4- The child can, through a set of activities related to blowing air, know the effect of wind on things in different situations, and how to use it as a force that has an amount and direction, and how this force can be controlled, utilized, and used in a set of gradual level experiments in a sequence that increases realization of the concept.

-Rolling

- The higher the mass and the velocity, the higher the kinetic energy.
- The effect of gravity on the movement of the body: If the body rolls on a sloping / inclined surface, the degree of inclination affects the amount of movement. As well as the direction of movement of the body with / against gravity.
- When one body slides over another, the force of friction between them is equal to the vertical reaction between the two bodies, when the amount of friction is minimal.
- The effect of gravity on the movement of the body is not absolute. If the body rolls, we have to calculate the slope of the surface on which the rolling motion takes place, if any.
- Stored energy that is transmitted in the form of movement (that is, energy begins as potential energy and then turns into kinetic energy).

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-Shadow

- The child, from an early age, follows the path of light by means of dust particles that are in the path of a beam of light rays. The sunlight he sees every day, which embodies the fact that light travels in straight lines, passes through a hole in the window of a darkened room. It comes as a non-dispersive beam of light that travels in straight lines to paint a spot on the floor of the room.
- The child recognizes light and shadow on their own. He sees things when light falls on them and is reflected from things to his eye. Step by step, he gets to know the luminous things, the sun, the candles, the lamp... and other things that are called self-lighting, that is, they emit light because they emit light in themselves. As for the things that he sees because the light falls on them and then is reflected from them to his eye, they are called non-self-lighting.
- Through experiments and activities, children will learn about the permeability of light, permeable, semi-permeable and opaque, given that the opaque body is the shadow.
- The objects permeable to light, they are not shadow. This is evident in scientific experiments to clarify the conditions for the formation of shadow.
- Children will learn about the effect of light on the size of the shadow, by approaching or moving away from the light source.

Data Collection and Analysis

To achieve the research objectives and answer the research questions, data were collected from different types of tools:

- Semi-structured interviews: The semi-structured interviews were relied upon to reveal the teachers' methods in implementing scientific activities with children in the activity halls and their opinion on the curriculum presented to the children.
- Audio recordings, videos, and photographs during the application of the tests and activities.
- Activity record for each child, researchers' notes during the activity, conversational learning experiences, and sample work. These data helped the qualitative analysis through the children's coexistence following the participatory observation.
- Diagnostic tests: based on which the desired objectives are achieved before and after the activities are determined.

Action procedures

To verify the credibility and effectiveness of educational activities, seven teachers who agreed to participate in the semi-structured interview were interviewed, and they were presented with tools and their steps for designing, and ways to present them to children through electronic links, and then their effectiveness was discussed. The teachers agreed that the tools were attractive to children and easy to design and presented as simple laboratory tools in the Discovery Corner. To ensure that children learned knowledge and skills related to the three physics concepts and to verify the effectiveness of the program in improving the learning process:

1. The children were introduced to the tasks required according to each activity.

2. Preliminary diagnostic procedures were carried out for each concept separately to ascertain the cognitive background of the children regarding the physics concepts in question using their specified tools and questions. For example, to identify the children's past experiences with the concept of the shadow, use the diagnostic procedures (Appendix A). Then, all observations about previous performances were recorded.

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Research Results

Children's Scientific Thinking Skills

To answer the first research question, children's performance on diagnostic tests related to the three concepts of blowing, rolling, and shadow was discussed. The results were interpreted according to the children's practices of the scientific activities in question, knowing that the children had no idea about the activities and tools provided to them. The children were given ample opportunity to explore the tools of each concept. Then, the test questions were asked for the three concepts according to the scientific processes and the questions shown in Table 2. After that, the children's responses to the three tests were collected and analyzed. The responses were recorded depending on the verbal and performance expression during the activities.

Table 2
Children's Responses to the Pre-Test of the Three Concepts

Specific science operations	Qualitative analysis of children's responses	%
		Researchers' analysis
Awareness	8/8 agreed that they did not see such tools. They did not understand what they were used for, and they were not able to determine the purpose of them.	0
Exploration	8/8 could not understand the elements of the situation, but they had poor information about the size and weight of some objects. Two of them pronounced light, heavy, and they had no knowledge of the degree of friction.	40
Investigation	8/8 random responses are not based on understanding.	0
Performance	8/8 random responses are not based on understanding.	0

By analyzing the children's responses, it is shown that the children were able to describe the tools in front of him, but they could not understand their use and relationship to the concept. They had never seen these tools before.

Excerpt (1) Children's conversations about the concept of rolling:

S1: I have a paper box, colored paper plates, lots of colored balls and other things.
S2: I will play tennis with it.
S3: The balls are large and small, and some of them are heavy.
S4: I have not seen these things before, but their colors are beautiful.

Excerpt (2) Children's conversations about the concept of blowing:

S1: I have little pebbles, paper boxes, little balls, juice tubes, and lots of colored paper.
S5: I don't know what to do with it. I can play ball.
S4: Can we blow all these things, they can all fly? Yes.

Excerpt (3) Children's conversations about the concept of shadow:

S2: I have an electric flashlight, and I have one like it at home, colored paper, and little paper dolls.
S3: I can color on paper.
S5: Things are hidden inside the box, I can light the lamp to see them.

Children's Knowledge of Specific Scientific Concepts

To answer the second research question, the activities of the program described above were designed in detail, and diagnostic tests were applied afterwards. The responses of the children were as follows:

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Table 3
Children's Responses to the Post-Test of the Three Concepts

Specific science operations	Qualitative analysis of children's responses	%	
		Researchers' analysis	Pre and post-test
Awareness	8/8 Correct responses about the tools, answer what you notice, and what happens first.	100	100
Exploration	7 / 8 correct responses about: What would happen if, and identify the properties of objects shape, size, texture, friction	88	48
Investigation	8/8 Correct responses related to the ability to understand and pay attention to what is happening and explain it, and the ability to experiment and test things.	100	100
Performance	6/8 Correct responses related to the ability to apply knowledge in new situations and use it to solve simple problems.	75	75

By analyzing the responses of children, Table 3 shows the children could understand their use of tools according to each concept, experiment and link them with models found in daily life, and thus answer based on understanding to the questions directed to them. This is evident from their responses.

Excerpt (4) Children's responses during rolling activities.

S1: If you hit the ball hard from bottom to top, it will go up the slope, but you can come back, but if you hit the ball on the ground, it will run forward.
S2: The ball drops quickly from the top of the slope like my father's car over the top.
S4: The box has difficulty falling down the slope, not like a fast ball.
S6: The ball and the cylinder are like some rolling quickly. "The child used his hands to represent the movement."
S1: Objects move with difficulty on course surfaces.

Excerpt (5) children's responses during blowing activities.

S1: I can move small things by blowing on them.
S2: The paper roller moves and moves the basket to the right and to the left when I blow with a force that rotates.
S3: It is difficult to move the basket, as it is heavy. We must reduce the grain inside it so that it can move up.

Excerpt (6) Children's responses during shadow activities.

S1: There are colored cards, but they are thick and do not let light through. Transparent cards only let light through.
S3: I can make a shade if I stand in the sun by the wall.
S3: Pictures get bigger when I move near the searchlight.
S2: We can make shadow for us in the dark using a torch.
S5: The circle becomes small or large when I move the light.
S5: I can make a bird's shadow with my own hands. Look.
S6: Cards with holes pass through the light, but little of it.

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Discussion

It is evident from the results that the children's understanding of the concepts of blowing, rolling and shadow has developed. It is also noted that the children's knowledge and experiences according to the pre and post-test differ in terms of the concept nature, the amount of knowledge, and their previous experiences. Children's past experiences influence efforts to impart scientific knowledge (Ravanis, 2021). One of the concepts that most attracted children's attention is the concept of shadow. This may be due to the playful nature of the subject of shadow as it took the form of playing with shadow rather than experimenting. It was a very interesting topic for them. As for the subject of blowing and rolling, they were topics of great familiarity to them. This made it easier to represent them with real things in their daily lives and is consistent with the established standards.

Referring to the descriptive responses of children, it was found that children practiced many science operations. By observing the child's interaction with scientific experiences, their interaction with tools and their behavior during the application, it was found that children mastered description, which is one of the science processes. Children at this stage have verbal mastery and the ability to verbally express. This result is in line with that of Kato and Meeteren (2008), who concluded that the scientific thinking of children developed in all the fields they practiced. They developed a sense of confidence and perseverance during the activities. The process of inference and experimentation also recorded high rates during the children's dealing with the tools, which indicates their exploration behavior. This includes their understanding of the elements associated with things, people, and phenomena. It also includes their ability to observe, measure, classify, gather information, and experiment, which led them to inference. This indicates their adequate exploration practice.

This finding is consistent with the growth characteristics of children at this stage and their craving for learning about things around them. The children also practiced investigation, which included deepening their understanding of things, focusing attention, making hypotheses, making comparisons, interpreting, and the ability to predict but with a lesser degree of description and experimentation. This result may be due to the fact that it is a mental process that needs to perform many other mental operations. It requires a great deal of thought and concentration. According to Ravanis (2021), children are given opportunities to internalize physics knowledge through experimentation and manipulation of specially constructed, selected, and organized learning materials and environments.

Finally, the children who were directed to the planned activities achieved a clear superiority. In general, children's previous physics experiences are an important indicative factor in predicting their performance. Accordingly, it can be concluded that the competent educational content can contribute to the achievement of the basic competencies required to be achieved and the achievement of educational and training purposes at the same time. It may turn out that the issue of the children's past experiences is very important, and that this lacks a deeper understanding of those dealing with the child. The natural environment of the child has endowed him with all the means and ways to enhance his physics knowledge, and parents and teachers must develop that knowledge artistically and skillfully based on a culture of the nature of scientific knowledge in the first place.

As Fragkiadaki and Ravanis (2015) state, children are in dire need of their speech-language, and they lack clarity of vision in terms of ways of presenting topics, rate of speed in presentation, familiarity with the details of the topic, and the use of words in appropriate context diversity in the use of formal and informal methods, and lively discussions. These and other things drive young learners to participate and interact. This can be achieved if we find what we offer the young people of knowledge planned consciously.

Finally, most studies on science education agree on the importance of introducing science early, but the focus is on the teacher's role more than the learner's. These studies are more concerned with theorizing than putting steps into practice. Nasrudin et al. (2021) confirmed that physics is an important topic and introducing physics from an early age is essential. The study revealed various ideas about efforts to introduce physics to early childhood. It followed the qualitative approach and used semi-structured interviews and focus group discussions with experts in physics education, linguists, administration, and early education. It concluded that physics should be simpler to understand. Feng's (1987) study also emphasized the nature of science and children, and how this nature affects preschool science education where children learn best through active hands-on activities. In addition, it emphasized the role of the teacher. Here, theoretical interest in the content and the teacher is found in both studies; however, these studies lack how those activities were implemented. Hence, the current research is unique in developing a mechanism to simplify physics concepts according to levels that correspond to children's abilities and to clarify how physics concepts can be converted into simple laboratory tools that children can deal with. It also explained

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the steps for actually implementing the activities with the children, and how dialogue and discussion took place during the work. This makes it a real pleasure that ultimately leads to authentic learning.

In this research, it was found that simplifying physics concepts according to cognitive levels could develop children's knowledge about those concepts in a more organized manner. Thus, simplified activities according to levels of knowledge are commensurate with kindergarten children. They could indicate the success of introducing physics to them. However, the current research has limitations. First, the sample was selected following the purposeful sampling technique rather than the random sampling technique. Also, only third-level children of the age groups (5-6 years) participated in the research. Children of levels (1, 2) of different ages may give different results. In addition, only three concepts were presented. It was possible to expand on simplified concepts but might take a long time to build and implement the physics tools. Furthermore, the diagnostic tests were used to determine children's physics knowledge before and after introducing the simplified activities. Finally, the study relied on semi-structured interviews to ask open-ended questions and film the children while working on the experiments to get the best results without bias as much as possible.

Conclusions and Implications

Previous studies focused on the theoretical aspect that illustrates the relationship between science and children, the importance of introducing science early, and the role and teaching competencies of the teacher. However, none of the previous studies provided a mechanism for implementing this. This is what is unique to the current research, whose results focused on the steps to simplify the natural sciences, and how they could be presented in a simplified manner. The simplified physics concepts activities introduced to children also provided a good insight into the natural sciences in the early childhood classroom. They are not static activities, which are not popular with children. The current research has proven the extent to which children accepted group work and discussions among themselves, and their acceptance of the scientific idea that corresponds to their cognitive levels. This work may pay off, and a science club outside the routine of the children's day can be set, as this is what they need.

Recommendations and Suggestions

The current research recommends the availability of studies showing the quality and specifications of programs that fit the nature of the early childhood education process. Also, the scientific topics presented in the subjective curriculum of kindergarten children in the Kingdom of Saudi Arabia must be reviewed so that it is central and effective. In addition, attention should also be paid to simplifying science in its various fields of life and living organisms, physics, chemistry, earth, and space sciences, and presenting them to children in the form of early sensory activities. These themes are already available in the developmental learning standards in the Kingdom of Saudi Arabia (Ministry of Education, 2015).

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Declaration of Interest

The authors declare no competing interest.

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Appendix A: Program Implementation

1. Some Diagnostic Procedures for Each Concept

The teacher can do some diagnostic procedures with the children for each concept according to the following:

(a) Diagnostic Procedures for the Concept of Blowing

- She gives the children balloons to inflate, some are big, and some are small.
- She gives them a bicycle pump to fill a rubber space with air (a swimming collar for example).
- She asks them to sit near a fan and talk about how they feel.
- She asks them to make a paper fan and use it to move the air. Is there a difference between it and an electric fan? The children describe how they feel.
- She asks them to look at trees and observe them on a day when the air is moving, noticing things move by the air, and talk about what they notice.
- She asks them what the air does to their clothes, trees, balloons, swimming pool, hair, leaves and things around them. If they answer that it is moving, she asks again, does the air move things with the same force? And why?

(b) Diagnostic Procedures for the Concept of Rolling

- Rolling on the ground: The teacher asks the children to roll or rotate the body, using pushes with the hands and feet, so that the movement moves from the palms to the torso to the rest of the body. Thus, the movement can be represented physically, and this explains (the idea that the potential energy is already inside the stationary body, and the potential energy is transformed into kinetic energy, and is transmitted in the moving body from one part to another).
- Rolling forward or backward: The teacher discusses with the children the following: When you are rolling backwards, how did the movement move, from what part of the body did the movement begin, where did it move, and why?
- Rolling in other ways: The teacher asks the children, can you roll with your body in another way? Things that can roll: The teacher asks the children about things they know, that can roll, similar to what they acted out. Then, the teacher offers the child things and asks them to roll them such as a ball or a cylinder.

(c) Diagnostic Procedures for the Concept of Shadow

- The teacher chooses a sunny place in the garden next to a wall and asks the children to stand in the sun and do several actions, including hand movements, following their shadow on the wall, moving and following the shadow on the ground, and trying to catch the shadow. The teacher asks one of the children to stand in the sun to make a shadow and asks another child to follow the shadow of the first child and to try to draw the shadow on the ground.
- Then, the teacher asks the children: What color is the shadow? Did the color of the shadow change by changing the shape? Is the shade always black? What happens to your shadow when you run? Can you hold your shadow?
- The teacher asks the child to match his shadow to the shadow marks on the ground marked with chalk. The child moves away from and close to the shadow on the ground and tries to match his body to the shadow on the ground.

2. Designing five activities for each concept:

- Blowing activities include the following:

The blowing concept is presented in five gradient activities: blowing through a path, blowing through tinted windows, blowing a bird's feather to its nest, obstacles, and a fan.

- Activity: Blowing through a path: The scientific idea of the activity: The teacher should know:
- Air has a force of magnitude.
- The response of objects moving by the force of the air depends on the size of those objects, their shape, the nature of their smooth/rough surface, and heavy/light weight.
- Spherical objects are easier to blow and move under the influence of air force than flat objects.

Procedural objectives

- The child describes the movement of objects of different shapes and sizes on the path in front of him.
- The child tries to move objects along the track with his mouth/tube.
- The child explains which is easier to move objects through the mouth or the tube.

Used equipment:

https://doi.org/10.33225/jbse/22.21.928

- A thin tube for each child to use to blow air (avoid flexible tubes).
- A group of things of different shapes and sizes, and the outer surface. Some are also spherical or flat.
- Container for keeping things.
- Two paper tags, one of which bears a true mark and the other a false mark.
- Two tracks of paper as surfaces on which objects move.
- Colorful bar on each track as a target for the child.
- Air Blowing Activities Link https://www.youtube.com/watch?v=2Q2h0sNgMIl&t=1s
- Activity Procedures
- The teacher shows the children things to check and know them.
- The teacher asks one of the children to use the tube to blow objects over the track and try to reach the specified goal.
- The teacher asks the child to place objects that are easy to move due to the force of the blowing using the sign (√) and the things that are difficult to move using the sign (X).
- The teacher gives the child a chance to experience the effect of the force of blowing on the objects in the room or the objects that he wants to test to be affected by the force of air blowing.

Suggested questions about the concept of blowing through the path:

1- How do you move the ball through the inflatable tube without touching it, so that it reaches the specified goal?
2- Does a wooden cube need as much blowing force as a table tennis ball to reach the goal?
3- Which is heavier, the things that can be blown easily or the things that cannot be blown easily?

Demo situation controls:

- Introducing children to tools before working.
- The objects used are the same size but different in shape and weight.
- The things used varied between light and heavy, soft and coarse.
- Avoid flexible inflatable tubes because they affect and reduce the force of the air rushing out of them.
- Each child has his tube throughout the activities (health precautions).
- The child manipulates freely using the tube to inflate anything he feels he needs to test the effect of the force of air on him, even things that you think will not respond to the force of blowing.
- The child categorizes objects into two categories according to their response and non-response (things that can move due to the force of blowing and things that do not move due to the force of blowing).
- Rolling activities

They include the following procedures:

The rolling concept is introduced into five level gradient activities: rolling down the slope, hitting targets up the slope with the tennis ball, rolling up the slope, rolling tilting trails, and long-distance rolling.

Activity: Roll the ball across the slope.

Scientific idea of the activity:

The idea is based on controlling and directing together by rolling the child a number of balls on a tilting surface. It also revolves around recognizing the speed of the balls in hitting the targets, taking into account the amount of movement, the proximity and distance from the targets, and the degree of the tilting surface, noting that the movement is in the direction of gravity.

During the experiment, discussion, and dialogue, the teacher is supposed to explain to the children the following ideas:

- The movement of a rolling object on the tilting surface gives it a great speed when the surface slope is large.
- Large balls, the amount of movement is large, so they hit and drop targets.

Procedural Objectives:

- The child describes the movement of balls of different sizes and weights on the tilting slope.
- The child tries to move the balls on the tilting slope.
- The child explains which is easier to move on the slope, heavy or light balls.

Used equipment:

- Large triangular prism, made of cardboard or wood, is used on the tilting surface for rolling balls (the wide side of the prism is used for rolling).
- Rubber balls of different sizes (large, medium, small).

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- A set of objects to be used as targets such as boxes, cubes, and cylinders.
- Links to the rolling activities:
  https://www.youtube.com/watch?v=BriHvmAg9TM
  https://www.youtube.com/watch?v=jjgLjCwvGO0
  https://www.youtube.com/watch?v=fNHw50iBzl0

Activities with children:

1. The teacher allows exploring the tools.
2. Identifying the surface of the prism used as a tilting surface to make a rolling motion on it using the available rubber balls (large, medium, small).
3. The teacher asks one of the children to put targets in front of the prism, then another child uses the big ball to hit the targets that are placed in front of the prism.
4. A child tries to hit the targets by rolling the big ball over the prism.
5. The child classifies the targets according to their response to the fall, after the ball (large, medium, small) collides with them and identifies the targets as light, medium, and heavy in weight.
6. The teacher helps the children by raising the sides of the prism used as a movement level and raising them by placing a set of boards under it to increase the height of the prism and asks the child to try rolling the ball on it.
7. Colorful strips can be placed on the ground, at different distances from the targets, used to determine the starting point on which the prism is placed to determine the extent of proximity and distance from the target and know the distance through which the child can hit the target.

Suggested questions about the concept of rolling the ball across the slope:

1. Which balls are easiest to hit the targets?
2. Does the highly tilting surface help the ball roll more, or is the sloping surface low?
3. Is it easy to hit the target when the inclined surface is close to or far from the target?

Demo situation controls:

- The surface used for rolling is smooth for easy movement and made of light wood.
- Rolling balls of various sizes and weights to show the child the effect of the amount of movement through the strength of its impact on the target.
- Every two children cooperate in the experiment so that one of them rolls the ball. The other arranges the targets, and the two observe the movement of the ball on the tilting surface.
- Shadow concept activities

They include the following procedures. The concept of shadow is presented in five gradient activities: see the light, play with the shadow, select the shadow, match the shadow, and holographic shadow.

Example of one of the activities presented: Playing with the shadow

Scientific idea of the activity:

- In order to make shadow, the shape must be between the light and the barrier.
- Shapes that make shadow of impermeable shapes.
- The light source can be above or behind the figure to create shadow.
- Shadow can be received on any white space in front of the object such as a shadow theater.
- The shadow always takes the shape and color of the body that permeates the light.

Procedural Objectives:

- The child tries to make shadow using the tools in front of him.
- The child explains the reasons for changing the size of the shadow near and far from the light source.
- The child explains the reasons for the emergence of colored and non-colored shadow.

Used equipment:

- A large cardboard box, open on one side, with a hole perforated on the upper side to accommodate a light source (electric torch).
- Transparent shelf installed in the middle of the box.
- A set of different colored paper.
- Shadow activities link https://www.youtube.com/watch?v=tBJ11O6Dvfs

Activities with children:

- The teacher allows exploring the tools and how to use them.

https://doi.org/10.33225/jbse/22.21.928

- The child places the paper figures one by one on the shelf and highlights them from the hole designated for him, and the teacher asks him to look under the shelf and describe what he sees.
- The teacher discusses with the child the shadow under the shelf.
- Different transparent forms of light are used (dark, semi-opaque, luminous), and each time the child is asked to describe what he sees with the repeated use of the word shadow.
- Repeatedly, the teacher uses other opaque shapes in different colors and asks him to describe the shadow that is formed for them.

Suggested questions about the concept of playing with shadow:

1- If we put the light on top of the box facing the opening and put a picture of a duck on the shelf, where does the duck's shadow form?
2- What happens if you turn off the light, does a shadow form? Why?
3- Does the color of the shade change with the change of the shape on the shelf?
4- What happens if you move the light around the hole?
5- Does the shadow move as the shape on the shelf?

Demo situation controls:

The teacher must take into account the following points:

- The work area is dark.
- The shapes used are of different sizes, colors, and light transparency.
- A powerful light source is installed in the upper opening.

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