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The effectiveness of Blended Learning Strategy-Based Program on the Development of Physical Concepts among Early Childhood Stage Children

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Abstract: The study aimed to identify the effectiveness of using the blended learning strategy to develop physical concepts among children in the early childhood stage. The study sample consisted of 90 children, boys, and girls, aged 5 to 6 years, and registered in the government kindergartens in Najran city. The sample was selected randomly. The study used the descriptive approach and quasi-experimental with one experimental group. The study tools included a program based on using the integrated learning strategy to develop physical concepts in an early childhood stage. The illustrated physical concepts test for children in the early childhood stage was prepared by the researcher. The results have shown a list of physical concepts that can be developed in children in their early childhood stage. There is a statistical significance at a significant level of (0.05) between the average scores of children in the pre- and post-measurement in the dimensions of the illustrated test to measure physical concepts and the total score in favor of the post-measurement is attributed to the program based on the use of the blended learning strategy. Considering the results, the study recommended: holding training courses and workshops for kindergarten teachers on how to employ modern and advanced strategies in developing physical concepts differences in Children have, in light of modern and contemporary trends, directing early childhood program developers to the importance of including scientific concepts (physical - chemical - biological) in curricula.

Keywords: Physical concepts; Blended learning; Early childhood.

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فاعلية برنامج قائم علي استراتيجية التعلم المدمج لتنمية المفاهيم الفيزيائية لدى الأطفال في مرحلة الطفولة المبكرة

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مستخلص البحث: هدفت الدراسة الي معرفة فاعلية استخدام استراتيجية التعلم المدمج لتنمية المفاهيم الفيزيائية لدى الأطفال في مرحلة الطفولة المبكرة . و تكونت عينة الدراسة من90 طفلا وطفلة من 5-6 سنوات من المسجلين بالروضات الحكومية بمدينة نجران تم اختيار العينة بطريقة عشوائية . و قد تم استخدام المنهج الوصفي وشبه التجريبي ذو المجموعة التجريبية الواحدة. وشملت أدوات الدراسة علي برنامج قائم على استخدام استراتيجية التعلم المدمج لتنمية المفاهيم الفيزيائية لدى الأطفال في مرحلة الطفولة المبكرة . أختبار المفاهيم الفيزيائية المصور للأطفال في مرحلة الطفولة المبكرة (إعداد الباحثة) . و توصلت نتائج الدراسة الي اعداد قائمة المفاهيم الفيزيائية التي يمكن تنميتها لدي الأطفال في مرحلة الطفولة المبكرة ، توجد فروق ذات دلالة إحصائية عند مستوى دلاله (0.05) بين متوسطي درجات الأطفال فى القياس القبلى والبعدى في ابعاد الاختبار المصور لقياس المفاهيم الفيزيائية والدرجه الكلية لصالح القياس البعدى تعزى الى البرنامج القائم علي استخدام استراتيجية التعلم المدمج، في ضوء النتائج أوصت الدراسة: بعقد دورات تدريبية وورش عمل لمعلمات الروضة حول كيفية توظيف الاستراتيجيات الحديثة والمتطورة في تنمية المفاهيم الفيزيائية لدي الأطفال في ضوء الاتجاهات الحديثة والمعاصرة.، توجية واضعي برامج الطفولة المبكرة بأهمية تضمين المناهج بالمفاهيم العلمية (الفيزيائية – الكميائية – البيولوجية)

كلمات مفتاحية: المفاهيم الفيزيائية - التعلم المدمج - الطفولة المبكرة

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1. Introduction:

Children first years of life are the golden stage for their learning of various concepts because of their love of exploration and research which shape their personality in an early state of their childhood. They learn scientific concepts by conducting experiments on their own to come up with a conclusion and then interpret objects and scientific phenomena to identify their characteristics. Their study of the physical concepts provides them with an opportunity to understand the properties of objects and natural phenomena. Therefore, they develop a way of thinking to understand the surrounding environment and trying to interact with it. Diversity of learning strategies is important for the development of scientific concepts, especially physical ones, which require observations, comparison, and classification to come up with explanations for the results related to scientific experiments. Concepts link many facts and details and at the same time clarify the relationships that exist between them. Studying physical concepts increase the learners' ability to use the functions of science, interpretation, control, and prediction to help learners understand and explain many things that interest them in the surrounding environment. Therefore, developed countries have paid great attention to kindergarten stage. Thus, teachers introduce physical concepts to children to encourage them to explore the surrounded environment. Preschool teachers can foster this sense of exploration by directing children's interests and everyday experiences to science.

Ramadan's study which aimed to identify the effectiveness of a program based on using a scientific experimentation strategy to develop some physical concepts for a kindergarten child as a young inventor, judging that the physical experiments program had contributed greatly to the development of physical concepts. (Lioyd, 2016). Activities of universal concepts depend on spatial learning and visual-spatial thinking, which are central to teaching young children these concepts (Michail, Mari, 2016).

Learning physical concepts is important for a kindergarten child because they help him understand and interpret many things that attract his attention in the surrounding environment. A child can learn and respond to these concepts through play, as an active behavior through which the child discovers his surrounding environment. Thorough examination of a child's questions may reveal most of science basic concepts to be presented as soon as he begins researching, exploring, and questioning the phenomena around him. For instance, Sharona (2013) found that children who studied via blended learning strategy outperformed mates who learnt traditionally. In addition, Tekerel & Kandir (2017) claimed that children who were taught through scientific sense in science education-based-program were superior to colleagues in the control group and developed better practical and scientific skills in the posttest and note taking. Whereas, Sun, et al. . Aroniin, Sara, Kim, (2017), for example, emphasized the efficacy of kindergarten where children use modern technologies during lesson explanations. Kulgemeyer & Peters (2016), on the other hand, confirmed the quality of physics explanation via online explanatory video clips, while Samuelsson (2019) stressed the need for a learning screen as child traditional teaching methods do not stimulate development. Furthermore, Keil, et al. (2021) claimed that 3D environments simulate real world and allow the design of a user-controlled virtual character that shows the users' personal character where he can move freely within the virtual environment.

The importance of using blended learning method in teaching basic education is increasing. However, it has its negative aspects especially the unsafe use of computers and Internet. Although no one can deny the progress achieved in the world in the present era in the field of technology, contemporary world is still suffering from some problems that vary in their impact on humans among which problems related to the failure to account for computers' safety and Internet use rules (Batchelor, et al. 2012).

In addition, many important reasons stand for using blended learning to overcome obstacles of using e-learning without the educational integration of sciences, the most notable of which are: Internet slowness; lack of laboratories, devices and media; difficulty of applying evaluation methods; weakness of human relations between the teacher and student; the focus on hearing and sight only; weakness of learners' interaction with it; students search for inappropriate sites on the Internet; weakness of content in ready-made software that may focus on skill aspect without paying attention to the emotional aspect; and the fear of developing introversion in the learner (Su, et al., 2010), (Li, & et al, 2010), and Sun & Wang, 2010).

It is clear from the above that the researcher chose to use a blended learning strategy to develop physical concepts among children in their early childhood. It may be compatible with a group of changes in the learning system currently followed in kindergartens, which is the use of the national curriculum based on the use of the investigative method, which helps the child to learn interactively and actively and depends on developing creativity and self-learning in the children's hands.

2. Research problem

Through the researcher's field experience, as a faculty member supervising female field education student, we noticed the teachers' lack of awareness of the importance of physical concepts for children and a lack of teachers' interest in scientific concepts, especially physical and chemical concepts. She noticed that most of the teachers' focus when they address scientific concepts is on one aspect of the biological concepts related to the circle. It consists of displaying some pictures of animals familiar to the child's environment and providing some information about them, and that their knowledge of physical concepts does not go beyond the concept of buoyancy, the concept of dissolution, and the terrestrial globe. I also noticed that some teachers provide some tools for physical activities and place them in the discovery corner, but they do not give the activity to the children This is due to her lack of awareness of the importance of developing physical concepts in children in early childhood. By conducting a survey of teachers, who numbered 20 kindergarten teachers in government kindergartens, to identify the extent of teachers' interest in physical activities and the capabilities available in the kindergarten to implement physical activities, the following became clear: There is a deficiency in presenting physics concepts within the kindergarten due to the lack of tools for presenting physical concepts to children and their lack of awareness of the physics concepts appropriate for the kindergarten child. Through the researcher's review of a lot of literature, she found that there are many studies that indicated the importance of (physics for the kindergarten child: industry, future scientists Such as: a study (Khadija Muhammad, 2016), a study (Rasha Mahmoud, 2016), (Sahar Tawfiq Naseem 2017), (Hana Hussein, 2017), (Dlaz, 2018).

Richard (2015), on the other hand, claims that a large proportion of the child's mental development occurs in the early childhood stage. Thus, it is important to develop their accuracy perseverance from a younger age because educational objectives related to the individual's scientific formation look for being aware of the physical concepts, the role of scientists, and scientific discoveries in building a better future for humanity, in addition to science role and technology in improving life. USGS (2017) argues that the child's level of understanding of physical concepts differs according to their parents' level of their scientific thinking, academic achievement, intelligence, besides skills of observation and questioning.

Much of the previous research and studies have stressed the importance of developing children's physical concepts. For instance, Mohammad, et al. (2017), tried to identify the effect of sensory exercises on developing kindergarten children's universal physical concepts and thinking skills. He affirms the importance of adding some thinking skills to most programs and activities presented to children at pre-school stages such as diversifying scientific activities within their textbooks to develop some of their scientific concepts like concepts of universal physics, besides, fortifying the teaching activities with some sensory training, and equipping the teaching halls with some tools necessary to use sensory training with children. Al-Abadi's study (2019) includes the comprehensive interactive experience unit curriculum guide for kindergarten teachers, activities, games, and experiences that lead to kindergarten children's acquisition of physical concepts. Directing kindergarten teachers to provide activities and experiences that contribute to providing children with physical, chemical, biological, geological and other concepts that can be developed in kindergarten children.

Omar's study (2017) emphasized the necessity of providing an enjoyable learning environment for children to make learning science an easy and entertaining process. Ramadan's study (2022) focuses on the planners and developers of kindergarten's programs to the importance of incorporating advanced scientific experiments into the science curriculum in kindergartens, emphasizing the necessity of kindergarten children practicing exciting and advanced scientific activities, and helping them to research and question, in order to

become aware, proactive, persistent, and productive of knowledge. Abdel Aleem's study (2020) also recommended employing enrichment activities to develop many concepts for the child in kindergarten and providing kindergartens with a physical and technological laboratory suitable for the children.

Accordingly, the present study aims to reveal the importance of using blended learning through integration of interactive multimedia computer programs to develop and stimulate kindergarten's children to physical concepts and stimulate their motivation towards sell-learning.

3. Questions of the study

The present study aims to answer these questions:

1. What are the most important physical concepts that should be developed among early childhood children?
2. Are there statistically significant differences, at (α=0.05), between the main scores of children in pre- and posttests on each dimension of the physical concepts' pictorial test

and on the test's total score due to blended learning strategy-based program?

3.1 Study assignments

- Are there statistically significant differences at the significance level (0.05) between the average scores of the children in the pre- and post-measurements in the dimensions of the pictorial test to measure physical concepts and the total score in favor of the post-measurement, attributable to the program based on using the blended learning strategy?

3.2 Objectives of the study

The present study aims to achieve these objectives:

1. Identify the most important physical concepts that should be developed among early childhood children.
2. Address the effectiveness of blended learning-based program in developing physical concepts among early childhood children.

Study assignments

- Are there statistically significant differences at the significance level (0.05) between the average scores of the children in the pre- and post-measurements in the dimensions of the pictorial test to measure physical concepts and the total score in favor of the post-measurement, attributable to the program based on using the blended learning strategy?

4. Methodology

4.1 Study approach

The present study used both quasi-experimental and descriptive approaches of one experimental group to achieve its objectives. The experimental approach is used because the effect of independent variable can be easily defined on the dependent variable. However, the descriptive approach is used to collect, present, and analyze collected data that result in answering the research questions (Al-Mubathat, 2012).

4.2 Study population and sample

4.3 Population

Children enrolled in public kindergartens under the supervision of Early Childhood Education Department in Najran city (N=90) constituted the population of the present study. Their total number was (90) children. They were selected randomly

4.4 Sample

Thirty (30) male and female children learning in kindergartens in Najran city at the kingdom of Saudi Arabia constituted the sample of the present study. Their ages ranged between five and six years.

4.5 Study instruments

4.6 The present study used these instruments

First: A list of physical concepts that can be developed in children in early childhood (prepared by the researcher)

To determine the physical concepts that can be developed in children in early childhood, the researcher did the following:

- Objective of the list: The list aimed to identify physical concepts that can be developed in children in early childhood

Sources for building the list: The list was prepared by reviewing:

- Books and references that dealt with physical concepts that can be developed in children in the early childhood stage. Analysis of the units and topics of the kindergarten curriculum in the Kingdom of Saudi Arabia. To learn the physical concepts included in these units.
- A survey of kindergarten teachers' opinions about the physical concepts that can be introduced to children in early childhood.
- Preparing the initial image of the list: through the previous principles, after reviewing previous studies that dealt with developing scientific concepts in general and the concepts of cosmic physics.

The researcher prepared a list that included 10 physical concepts (the solar system - magnetic force - states of matter - lunar eclipse - lunar eclipse - refraction of light - solar eclipse - lightning and thunder phenomena - colors of the spectrum - weather) and it was presented to 40 teachers to determine the physical concepts that should be introduced to children in their early childhood, and after analyzing their opinions, 4 of the 10 concepts were excluded, namely (lunar eclipse - lunar eclipse - Refraction of Light - Solar Eclipse). Based on the teachers' opinions six concepts should be introduced to children in the early childhood stage. They were arranged according to their importance (weather - lightning and thunder phenomena - the solar system - magnetic force - states of matter - colors of the spectrum -) and a list of physical concepts was prepared by the teachers.

The list was presented in its initial form to a group of specialized arbitrators to verify the veracity of the list. To ensure that each of the physical concepts is appropriate for the children in the kindergarten. Add as they see fit.

Arriving at the final image of the list.

Second: Illustrated physical concepts test for children in early childhood (prepared by the researcher)

The Illustrated Physics Concepts Test for Early Childhood was constructed according to the following steps:

- Determine the purpose of the test: This test was built to identify the effectiveness of a suggested program based on the blended learning strategy for developing physical concepts among children in the early childhood stage.
- Sources for constructing the test: The researchers relied on the following sources to construct the test:
- Research and studies that dealt with the early childhood stage and its philosophies, and the characteristics of child development, as well as studies that dealt with physical scientific concepts and blended learning.
- Accessing books, magazines, and research concerned with physical experiments for children.
- To view a number of standards that dealt with the physical concepts of children in early childhood, including: the scale (Eunyoung, 2017, Pamela, 2020, Ibrahim, 2019
- Khalaf, 2020 - Al Bushi, 2021)
- Guided by the opinions of specialists and experts in the field of early childhood.

Use some clear, attractive, appropriately sized natural pictures that are suitable for display when formulating the test items.

The scale questions are presented in a gradual manner in terms of degree of difficulty.

Presenting physical concepts within the illustrated test in a sequential manner, according to the progression of their development in the kindergarten child.

5. Preparing test questions

He illustrated test consists of six main axes. The first axis is about the solar system and consists of (7) questions. The second axis is about the weather and consists of (7) questions. The third axis is about magnetic forces and consists of (7) questions. The fourth axis is about the states of matter (7) Questions: The fifth axis, about the colors of the spectrum, consists of (7) questions. The sixth axis, about the phenomena of lightning and thunder, consists of (7) questions. The total number of questions in 6 axes is 42 questions. From (multiple choice), in which the child is asked a question and is presented with some picture alternatives, then the child places a circle around the correct alternative that represents the answer to the question from his point of view, and since the test questions depend on pictures, it was considered that the pictures are clear, distinct, and appropriate. In terms of size, shape and colors.

6. Correction method

To obtain equal weights for the pictorial test, the test is of the multiple-choice type (A-B-C). The child circles the correct answer. The test consists of 42 questions. If the child chooses the correct answer, he receives one point. The total score for the test is 42.

6.1 Drafting selection instructions:

Instructions are one of the most important aspects of constructing a test. They aim to explain the idea of the test in the simplest possible way, the method of answering the questions, how to proceed with it, how to deal with the child, observing his behavior and estimating his grade, and directing him to how to answer the questions. The instructions are divided into two main sections: instructions for the teacher, and instructions for the children to whom the choice is applied. Selection instructions were placed on the first page and included the following:

A brief explanation of the purpose of the selection.

A statement of the number of selection questions.

Indicate that the answer will be on the test paper by circling the correct answer.

The researcher questions the child and shows him the pictures..

- Give an example to the child explaining how to answer the questions.
- Children should not begin answering the test questions until they are given permission to do so, and after they fully understand the test instructions.
- It is necessary to answer all test questions and not leave any question unanswered.
- The answer expresses the child's opinion without the intervention of the researcher.

Test validity.

6.2 Face validity

Thirteen (13) arbitrators were asked to validate the prepared pictorial test. They were all of expertise and have experiences in the field of the present study. Their viewpoints and comments about the suitability of vocabulary to the study subject, used activities and pictures to children age, and accuracy of items phrases. Some modifications were done considering arbitrators' comments.

6.3 Internal consistency

Correlation coefficients between each item's score and the score of the whole dimension to which it belongs were calculated to validate the test's internal consistency. Results are shown in table 1.

Table 1: Correlation coefficients between the scores of each test item and the total score for the dimension to which it belongs.

Study dimensions	N.	Correlation coefficients	Significance level	Statistical significance
Solar group	1	0.77	0.01	Significant
	2	0.83	0.01	Significant
	3	0.55	0.01	Significant
	4	0.53	0.01	Significant
	5	0.80	0.01	Significant
	6	0.74	0.01	Significant
	7	0.78	0.01	Significant
Weather	8	0.68	0.01	Significant
	9	0.62	0.01	Significant
	10	0.85	0.01	Significant
	11	0.85	0.01	Significant
	12	0.70	0.01	Significant
	13	0.63	0.01	Significant
	14	0.56	0.01	Significant
Magnetic power	15	0.64	0.01	Significant
	16	0.80	0.01	Significant
	17	0.80	0.01	Significant
	18	0.75	0.01	Significant
	19	0.77	0.01	Significant
	20	0.81	0.01	Significant
	21	0.83	0.01	Significant
States of the material	22	0.70	0.01	Significant
	23	0.66	0.01	Significant
	24	0.48	0.01	Significant
	25	0.64	0.01	Significant
	26	0.68	0.01	Significant
	27	0.77	0.01	Significant
	28	0.49	0.01	Significant
Colors of Spectrum	29	0.54	0.01	Significant
	30	0.58	0.01	Significant
	31	0.69	0.01	Significant
	32	0.71	0.01	Significant
	33	0.63	0.01	Significant
	34	0.71	0.01	Significant
	35	0.61	0.01	Significant
Phenomena of lighting and thunder	36	0.78	0.01	Significant
	37	0.66	0.01	Significant
	38	0.75	0.01	Significant
	39	0.72	0.01	Significant
	40	0.52	0.01	Significant
	41	0.72	0.01	Significant
	42	0.57	0.01	Significant

Results in table (1) shows that all correlation coefficients between the score of each test item and its dimension's total score were statistically significant and were ranging between (r=0.48) and (r= 0.85). That is, the test can be accounted for as appropriate for which it was prepared to measure.

7. Results of test construct validity

To verify the validity of the construction of the test, correlation coefficients between each dimension's total score and test total scores were calculated. Results are presented in Table 2.

Table 2: Correlation coefficients between each item's score and the test's total score.

Study dimension	Correlation coefficient	Significance level	Statistical significance
Solar group	0.90	0.01	Significant
Weather	0.79	0.01	Significant
Magnetic power	0.84	0.01	Significant
States of the material	0.90	0.01	Significant
Colors of spectrum	0.89	0.01	Significant
Lighting and thunder phenomena	0.84	0.01	Significant

Results in table (2) show that correlation coefficients between each dimension's total scores and the test's total scores were statistically significant. They were between (r=0.79) and r=0.90). That is, the test was valid and consistent.

7.1 Results of test reliability

Cronbach Alpha was used to check the reliability of the pictorial test. Results are presented in table 3.

Table 3: Cronbach Alpha coefficients for test reliability

Study dimensions	N. of items	Cronbach Alpha coefficients
Solar group	7	0.84
Weather	7	083
Magnetic power	7	0.89
States of material	7	0.75
Colors 0f spectrum	7	0.76
Lighting and thunder phenomena	7	0.80
Total score	42	0,95

Results in table (3) indicate the prepared test was reliable. Correlation coefficients ranged between (r=0.75) and (r=0.89). To put it differently, the test was reliable, and the results are acceptable and trusted.

7.2 Blended learning-based-program

7.2.1 Objectives

The main aim of the proposed program is to address the effectiveness of using blended learning as a teaching strategy in developing the physical concepts of early childhood children.

8. Resources

The followings were referred to as resources for the program's design and production in the present study:

1. Related literature and previous studies addressing kindergarten stage and philosophy, child characteristics, blended learning strategy, and kindergarten children's physical concepts.
2. Programs that used different strategies to develop kindergarten children's physical concepts, such as Ahmed (2014), Eunyoung (2017), Michail (2017), Khalaf (2020), Al Boushi (2021).

9. Philosophy

Piaget's theory was the basis for the philosophy of the present study because of the similarity of kindergarten objectives and the philosophy of preparation programs in particular, and the educational philosophy and the philosophy of kindergarten's co-curricular activities that use multiple senses. The philosophy of this study's program stemmed from the keenness to develop children's physical concepts that help them to understand the surrounding world. Scientific progress and knowledge of the world's latest natural and physical explanations are two characteristics of today era. Kindergarten teachers through their daily programs introduce attractive and interesting learning environments for children to achieve their desires, abilities, and aptitudes. Other philosophies deal with the learner as the centre of the educational process were considered as well.

9.1 Program duration

The program lasted for (6) weeks, and they meet three times a week ,starting on 4/6/1445AH to 13/7/1445AH. Two activities of (30) minutes each using blended learning were implemented each day.

9.2 Program content

The program consisted of (36) different activities using blended learning strategy to develop kindergarten children's physical concepts, i.e. the solar system, magnetic force, states of matter, lightning and thunder phenomena, colours of spectrum, and weather. Cartoon films, realistic three-dimensional images of the child's real environment, pictorial stories and books, a computer, and data show were the main tools used to carry out the program. Furthermore, a set of foundations were taken into consideration and contributed to the success of the program like:

1. The familiar relationship between the teachers and participants.
2. The gradual movement from simple to complex concepts.
3. The activities reliance on sound, images, and movement chosen from the natural environment.
4. The diversification of reinforcement methods used.
5. The program's reliance on group activities and individual work.
6. The adaptation of program content to children's characteristics and needs.
7. The inclusion of activities and events that arouse children interest.
8. The consideration of integration in provided activities.
9. The program's contribution to the development of children physical concepts.

9.3 Techniques and methods used in the program

1. Indoctrination, i.e. providing assistance of all kinds, especially verbal and indicative.
2. Task analysis where complex tasks were split into small parts to be easily executed.
3. Modelling to create experiments related to physical concepts in front of children.
4. Role playing, i.e. the teacher asked the child to repeat the presented concept.
5. Feedback, I. e. correction and clarification of information were provided when the child did not understand.
6. Individualization of education, which is individual treatment of each child according to goals that suit his abilities.
7. Directing the child's attention to through augmented reality technology.

9.4 Strategies used in the program

1. Brain storming.
2. Dialogue and discussion.
3. Reinforcement strategy.
4. Problem - solving strategy.
5. Guided discovery learning strategy.
6. Observation and conclusion strategy.
7. Practical presentation strategy.
8. Educational scientific games strategy.

9.5 Steps of program implementation

- Preparation: The teacher stimulated children's thinking at the beginning of the activity using some pictures and brainstorming method.
- Modelling: The teacher presented the activity using scientific experiments, realistic 3D images close to the child's real environment, … etc.
- Guided practice: The teacher asked children to repeat the activity with her or immediately after her.
- Independent practice: The teacher asked children to carry out the activity alone so that he can perform it well.
- Application: The child applied the concepts he acquired in a new situation.
- Evaluation: The teacher used evaluation activities to ensure that the program objectives were achieved

9.6 Evaluation means used in the program

The following types of assessment were used:

1. Pre-assessment
2. Formative assessment
3. Summative assessment

9.7 Study procedures

The study went through these steps:

1. Reviewing previous studies to formulate the theoretical framework and define study tools.
2. Identifying the initial list of the physical concepts that should be developed among early childhood children.
3. Determining the final list of the physical concepts that should be developed among early childhood children
4. Preparing the pictorial test and then validating and verifying it.
5. Asking for the permission of stakeholders of early childhood education to conduct the study.
6. Conducting a pilot study on (30) children.
7. Preparing the blended learning -based program.
8. Defining the appropriate activities for each concept.
9. Carrying out the study on the selected sample.
10. Tabulating and coding data using (SPSS) program.
11. Analyzing collected data and answering the questions
12. Interpreting and discussing the results.
13. Writing the most important recommendations.

9.8 Statistical analyses

SPSS 25 program was used to conduct the following statistical analyses:

1. Pearson correlation coefficient.
2. Cronbach's alpha coefficient
3. Difficulty and discrimination coefficients
4. Mean scores and standard deviation
5. T. test
6. Effectiveness ratio equation
7. Eta square formula ($\eta 2$)

10. Results and discussion

10.1 Results related to the first question

At which states and what physical concepts can be developed in children in early childhood?

The two researchers prepared a list that included some of the physical concepts suitable for kindergarten children, after reviewing previous studies which concentrate on developing scientific concepts in general and universal physics concepts in particular, such as the study (Al-Abadi, 2019), (Khalaf, 2020), (Abdul Aleem, (2020), (Ramadan, 2022). In its initial form, the list consisted of a set of physical concepts that need to be developed by kindergarten children. Their number reached 10 concepts (the solar system - the magnetic force - states of matter - lunar eclipse - lunar eclipse - refraction of light - solar eclipse - the phenomena of lightning and thunder - colors of the spectrum - weather). Concepts were presented to 40 teachers to determine the physical concepts that should be introduced to children in early childhood and after analyzing their opinions, 4 of them were excluded, namely (lunar eclipse - lunar eclipse - light refraction - solar eclipse) based on the teachers' opinions, six concepts should be developed in children in the early childhood stage. They were arranged according to their degree of importance (weather - lightning and thunder phenomena - the solar system - magnetic force - states of matter - colors of the spectrum). The list was presented in its initial form to a group of professors, specialists in the field of childhood and technology, in order to learn about their point of view in terms of the suitability of each of the physical concepts for the kindergarten child, and to add what they deem appropriate. The opinions of His Excellency the arbitrators agreed that these concepts are appropriate for the characteristics of children at this age. They also agreed that the list achieves the goals for which it was designed, in addition to that there was no difference in the clarity of the vocabulary or its suitability to the subject of the study. However, there were some proposals that were agreed upon by His Excellency the arbitrators, which were taken into consideration, and in light of them, the necessary amendments were made until a list of physical concepts was reached in its final form.

The result is consistent with the findings of two studies:

Samir (2017) who came up with a list of physical concepts that should be developed among children in early childhood (heat, electricity, light, matter, force) through a survey of kindergarten teachers' opinions. And the study by Dlaz, M, 2018, which came up with a list of physical concepts that should be developed in children in early childhood (magnets, light, sound, and heat) through a survey of kindergarten teachers' opinions. .

Abdel Aleem, (202), who came up with a list of physical concepts that must be developed in children in early childhood. Light - Movement - Magnetism) through a survey of kindergarten teachers.

Through the previous presentation, the importance of physical concepts for kindergarten children becomes clear, which encourages curriculum planners to diversify the strategies used to simplify physical concepts.

10.2 Results related to the second question

To answer the second question "Are there statistically significant differences, at (α=0.05), between the main scores of children in pre- and posttests on each dimension of the physical concepts' pictorial test and on the test's total score due to blended learning strategy-based program?" T. test was used, and the results are shown in table 4.

Table 4: Differences between children mean scores in the pre- and posttests of on the Pictorial Physical Concepts Test.

Study dimension	Test	M	SD	T. test		
				T. value	Df	Significance
Solar system	Pre-test	1.84	0.898	33.18	89	0.001
	Posttest	5.49	0.658			
Weather	Pre-test	1.97	0.854	37.28	89	0.001
	Posttest	5.67	0.54			
Magnetic force	Pre-test	2.01	0.918	33.03	89	0.001
	Posttest	5.52	0.657			
States of material	Pre-test	2.02	0.848	33.66	89	0.001
	Posttest	5.62	0.57			
Colours of spectrum	Pre-test	1.86	0.868	33.13	89	0.001
	Posttest	5.57	0.619			
Lighting and thunder phenomena	Pre-test	1.99	0.930	34.27	89	0.001
	Posttest	5.54	0.58			
Total score	Pre-test	11.69	2.282	81.57	89	0.001
	Posttest	33.41	1.498			

Results in table 4 indicate the significant differences between children's main scores in both pre and posttests in the physical concepts pictorial test regarding study dimensions and regarding the total score. Participant children's mean score in the pre-test regarding the solar system concept was (M=1.84) whereas it was (M=5.49) in the posttest. The main scores, in accordance with weather concept were (M-197) in the pre-test and (M=5.67) in the posttest. Regarding the magnetic force, the main scores were (M= 2.01) and (M=5.52) in the pre and posttests respectively. The main scores regarding the states of material concepts were (M= 2.02) and (M=5.62) in the posttest. In addition, the main scores, in accordance with, the colours of spectrum were (M=1.86) and (M=5.57) in the pre and posttests respectively. Mean scores of children on the lighting and thunder phenomena were (M=1.99) in the pre-test and (M=5.54) in the posttest. Finally, the mean scores of children's total score on the test as a whole was (M=11.69) in the pre-test whereas, it was (M=33.41) in the posttest. In other words, it can be strongly argued that the prepared program was effective in developing the physical concepts of early childhood children in kindergarten.

Findings in table 4: Clearly the achievement of the second hypothesis indicates that "The blended learning strategy-based- proposed program achieves the expected appropriate effectiveness in developing physical concepts among children. To ascertain the correctness of this hypothesis, equation of Black's modified gain ratio was used to explore the effectiveness of the proposed program in developing physical concepts among the research sample. Results are shown in Table 5.

Table 5: Modified gain ratio of the blended learning-based-program

Study dimension	Test	M	Total score	Modified gain ratio
Solar system	Pre-test	1.84	7	1.23
	Posttest	5.49		
Weather	Pre-test	1.97	7	1.26
	Posttest	5.67		
Magnetic force	Pre-test	2.01	7	1.21
	Posttest	5.52		
States of the material	Pre-test	2.02	7	1.24
	Posttest	5.62		
Colours of spectrum	Pre-test	1.86	7	1.25
	Posttest	5.57		
Lighting and thunder phenomena	Pre-test	1.99	7	1.22
	Posttest	5.54		
Total score	Pre-test	11.69	42	1.23
	Posttest	33.41		

* As determined by this equation, the gain ratio to be accepted as effective should be (1.2) or above

As indicated in table 5, the proposed blended learning-based program in developing the physical concepts to children was effective. Its effectiveness extended from (1.21-1.26). The total effectiveness gain ratio was (1.23). Thus, it was of clear efficacy and could develop the quality of participant children's physical concepts. To confirm the result, Eta square (η2) was used to check the effect size of the proposed program on the development of children's concepts. Table 6 presents the results.

Table 6: Size effect of the proposed program on developing children's physical concepts:

Study dimensions	T value	DF	η2
Solar system	33.18	89	0.925
Weather	37.28	89	0.940
Magnetic force	33.03	89	0.925
States of material	33.66	89	0.927
Colours of spectrum	33.13	89	0.925
Lighting and thunder phenomena	34.27	89	0.930
All physical concepts	81.57	89	0.987

*The effect size is considered small if (η2=0.01), medium if (η2=0.06), and large if (η2=0.14)

Calculations in table 6 show the high effect of the proposed blended learning-based program on the development of children's physical concepts. Eta square (η2) values for study dimensions ranged between (0.925- 0.940) and the program's total size effect was (0.987). In other words, the proposed program was statistically effective and help to improve children's physical concepts.

11. Discussion of the results:

Results in table 2 and table 3 show the high effect of the proposed program in developing the children's physical concepts at kindergarten. There are significant differences at (α=0.05) between the main scores of children's results in both pre and posttests regarding each study dimension score and the total score on the pictorial physical concepts test. This result is very similar to the results found in many studies such as; (Mohamed, 2019) (Dogru M. & Şeker, F. 2012) (Ahmed, 2019). Combining the effective role played and activities in developing many physical concepts for children in kindergarten is very beneficial. Abdel Aleem ((2020) affirmed the effectiveness of the proposed program based on YouTube videos and activities to develop some physical concepts for children in kindergarten.

Sun & Wang (2010), Li, et al. (2010), and Su (2010) highlight the effectiveness of using blended learning to overcome the obstacles of using eLearning without science educational blending. These obstacles involve the slow Internet; lack of laboratories, devices, and media; difficulty of applying evaluation methods, weakness of teacher-student human relations; focus on hearing and sight senses only; students' weak interaction; and students search for inappropriate sites on the Internet. The results match with the founding in Reisoğlu, Topu, & Beta's study (2017) regarding the virtual environments, which include activities difficult to be safely practiced in real life situations except through interaction with Internet objects in different places. The Results also affirms the findings of Aroniin, Sara, Floyd, & Kim's study (2017) which emphasized the efficacy of including modern technology when teaching children. Kulgemeyer & Peters (2016) highlighted the quality of physics teaching via an illustrational online video clip. Furthermore, the results agree with Sharona's study (2013) which affirms the superiority of kindergarten children who were taught through this methodology. Tekerel & Kandir (2017) showed the effectiveness of a scientific sense-based science teaching program on the development of children's scientific and practical skills.

It is clear from the above examples that the effectiveness of using sensory and electronic activities in developing physical concepts to children in kindergarten. When we combine sensory and electronic activities, they have a stronger effect in helping the child to understand the physical concepts, which indicate the importance of blended learning in developing the physical concepts in the kindergarten child.

The findings of the present study regarding the differences between the achievement of children in the pre and post-tests can be referred to a set of reasons among which are:

1. Diversity in the program's activities used such as the sensory activities, physical experiments, cartoon films, and virtual environments, which helped children to easily comprehend the physical concept.
2. Diversity of the strategies used, such as problem-solving strategies, brainstorming, scientific experimentation, reinforcement, educational scientific games, observation and deduction, practical demonstrations, and dialogue and discussion.
3. Program's attractiveness that enabled children to enjoy it.
4. Vividness and tangibility that blended learning strategy provided physical concepts, through children's thinking and contemplation processes while practicing physical experiments
5. Encouragement with which blended learning provided children to actively participate in activities and consequently improve their performance.
6. The inclusion of scientific experimentation could challenge children's abilities, pushed them to achieve, and encouraged them to provide many possible explanations.
7. The inclusion of scientific experimentation socially supported all children and creating desire and motivation in the learning process.
8. Blended learning contributed to the provision of scientific and educational environment and helped children to watch events, organize information, and predict what will occur.

12. Recommendations:

1. Hold training workshops for kindergartens' teachers about how to use modern strategies in developing physical concepts in light of current and recent trends.
2. Make available interesting environment for children's learning to make science learning easy and interesting.
3. Direct the attention of kindergarten program planners and developers to the importance of blended learning in developing children's scientific concepts.
4. Direct early childhood program designers to the importance of including scientific concepts in curricula whether physical, chemical, or biological.
5. Emphasize the importance for the kindergarten child to practice exciting and developed scientific activities that help in research and questioning to be aware, initiative and productive.

13. Suggestions for further Studies:

1. The effect of using blended learning on developing chemical concepts among kindergarten children.
2. The effectiveness of using the visual approach to help children acquire some physical concepts among kindergarten children.
3. The effectiveness of scientific experimentation strategy in developing chemical concepts among kindergarten children
4. The effectiveness of concept mapping strategy in developing biological concepts among kindergarten children.

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