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Research Article

Effects of a Proposed Unit Based on the STEM Approach in Developing Fundamental Science Processes for Kindergarteners in Makah Al-Mukarramah

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This study explored how a proposed unit based on the STEM approach affected the development of some basic science processes among kindergarteners in Makkah Al-Mukarramah. The descriptive-analytical method was thus employed, followed by an experimental approach with semi-experimental design for one group of children. The study tools included an image test for basic science operations. Furthermore, supportive materials were established, consisting of a proposed unit based on the STEM approach that included a teacher's guide and activities for children. The study tools were tested for validity and reliability, with applications before and after among a sample of 30 children (girls and boys) from Al-Ma'ali kindergarten in Makkah during the first semester of 1443. The most important findings were as follows: there were statistically significant differences between the average scores of children in the pre- and postapplications for testing basic science operations. As all *t*-test values for scientific operations were statistically significant at the <0.05 level, these differences were in the direction of application in the dimension with a higher arithmetic mean. In light of this evidence, several recommendations and proposals are offered. First, the results emphasized the usefulness of the STEM approach at the kindergarten stage, as this positively affected the development of basic science processes for kindergarten children. Second, this study recommends holding training sessions for kindergarten supervisors and teachers to introduce the STEM approach, its significance, and ways to apply it in the daily kindergarten program. Finally, this study highlights the need for additional research on the effectiveness of the STEM approach in the development of many different variables, including problem-solving skills, creative thinking, and 21st-century skills among kindergarten children.

1. Introduction

The Kingdom of Saudi Arabia makes great and continuous efforts to develop education and improve its quality at all levels. It has taken serious steps to support education at the kindergarten stage and provide high-quality care for children, especially in response to growing evidence of the economic and social benefits of education at that stage. Children are the source of real wealth for societies. They are the hope for a bright future.

The Kingdom of Saudi Arabia vision 2030 emphasizes the importance of investing in education and providing citizens with the knowledge and skills they need for future jobs, as these skills and abilities are among the most important resources [1]. The kindergarten level is especially emphasized because it is positioned at the most important stage of human life. During these early years, children build knowledge and skills that lay the foundation for future learning.

Science processes are the applied aspects of science. For children, the method of obtaining knowledge and its importance are thus highlighted, which contribute to the advancement of their thinking while enabling them to access information on their own rather than receiving it directly from the teacher. This makes them a central focus in the learning process, as is called for in modern theories.

Children are active by nature, are curious, and love research. They observe, marvel, search, experiment, discover, ask, and inquire, all of which are skills needed for most science processes. Shahda [2] defined science processes as “a set of mental skills, activities, and actions undertaken by the learner,” “during research and investigation with the aim of explaining phenomena or events” (p. 358).

Many studies have demonstrated the importance of developing science processes at all different school levels, including kindergarten. According to Hashem [3], science processes represent a global trend in contemporary curricula, wherein children are provided with direct experiences that create positivity in the learning process and facilitate their interaction with the surrounding environment. Hassan and Imam [4] also recommended the development of kindergarten programs that suit the mental needs of children and help to develop their learning processes.

Several reform movements have emerged in scientific education and science curricula, the most prominent of which is the science, technology, engineering, and mathematics (STEM) approach. It is considered one of the most important global approaches in the United States of America. Vasquez et al. [5] explained STEM as follows: interdisciplinary learning breaks down the traditional barriers that separate the four disciplines and integrates them into realistic, nuanced, and connected learning experiences for students (p. 18).

Chesky and Wolfmeyer [6] listed several goals that clarify the STEM initiative, the most important of which is preparing a future generation to become a strong and highly competitive labor force in the global market. As Savinskaya [7] explained, STEM skills are increasingly gaining importance; they provide job seekers with a competitive advantage in the labor market and represent the minimum work requirements in nearly all areas of employment.

For children, the STEM approach transforms theoretical knowledge into practice related to reality and surrounding life; this is accomplished through integrated educational programs that enrich children by teaching them skills that are based on real experiences, thus instilling a spirit of initiative and cooperation while enhancing their problem-solving skills [8].

Several studies have emphasized the importance of STEM entrance, with recommendations to begin the process during the kindergarten stage. Akturk and Demircan [9] reported on the inclusion of STEM education in kindergarten classrooms, which constitutes a new field of research in national and international literature. However, there is limited evidence on how the integration between STEM fields contributes to learning among kindergarten children. The integration of the four STEM domains into one lesson or unit depends on inter-relationships between relevant topics and real-life problems. In this way, children can put theoretical knowledge into practice, production, and innovation. Fan and Ritz [10] described STEM education as a modern phenomenon that aims to increase children’s understanding of STEM topics so that they can apply this knowledge in solving complex problems they encounter in real-life situations. As reported by Park et al. [11], early STEM experiences from kindergarten to the third grade play important roles in the enhancement of knowledge, skills, and inclinations necessary for future jobs, thus preparing children for an economy that requires innovative solutions to complex problems.

Given the demands of the information age and explosion of knowledge, Soylu [12] highlighted the importance of ensuring that every kindergartener has access to a qualified STEM education, which is a logical investment for a country that intends to strengthen its capacity for sustainable development. In this context, it is imperative to raise the creative and critical thinking abilities of citizens, who can apply this knowledge when attempting to solve problems in daily life. In turn, the nation can compete with other countries in the 21st century. This can be accomplished by integrating STEM fields and building links with the daily lives of children. In the same regard, Savinskaya [7] explained the first topic presented in a report by the US National Academy of Sciences in dedication to the future national labor market, which is the need to provide STEM education to kindergarten children. As discussed in the report, many studies have demonstrated links between preschool STEM learning and success in computer science and engineering during middle and high school. Moreover, the report indicated that it was necessary for children to learn about these topics at an early age when they can absorb information on the latest innovations easily.

2. Materials and Methods

2.1. Study Problem and Questions. The kindergarten stage is important because it helps children achieve success in their future academic lives. A child who excels in mathematics and science in early childhood will be distinguished in the later stages. However, the results from the international TIMSS test for mathematics and science in 2019 showed a decline among fourth graders in primary school, which may indicate a flaw in the early childhood curricula.

While supervising the field training of kindergarten students, the researcher noticed that scientific activities of lower levels were initiated. This resulted in a failure to enrich the discovery corner with practical scientific experiments appropriate for helping kindergartners develop basic science processes. This has been confirmed in many previous studies. For example, Sharif [13] noted the importance of helping kindergartners develop the skills needed for basic science process skills, which suited the nature of their current stage. Asiri [14] discussed the need to provide the research and discovery corner with materials and tools that helped children develop scientific thinking skills and science processes. The requirements of the scientific culture in kindergarten suffer from several problems, including shortcomings in the concepts of achieving scientific culture, weak basic scientific knowledge, and moving away from scientific ways of thinking.

Since the practice of basic science processes is an important component of science, learning them is one of the most important goals of scientific education. This is useful for both understanding the nature of science and transmitting the impacts of learning, which requires looking for modern strategies and approaches that ensure the safety of developing basic science processes in kindergarteners. As a modern way of achieving these goals, the STEM approach successfully integrates the science, technology, engineering, and mathematics disciplines. As such, children can shift from the stage of receiving information to that of discovery and experimentation while enjoying the process. By participating in simple activities and projects that are commensurate with their abilities, children can enhance their knowledge and learn to solve life problems in creative ways.

Additionally, some foreign studies have emphasized the importance of introducing STEM in kindergarten, particularly due to its role in developing future academic abilities in science and mathematics. With the aim of using technology and engineering to enhance creative/innovative thinking and improve 21st-century skills, Tek et al. [15] argued that STEM should be integrated into current children's curricula, including efforts to develop more STEM projects in various early childcare centers in Malaysia. Similarly, Torres-Crespo et al. [16] confirmed that a STEM summer camp encouraged children to solve real problems in a fun way through play while also helping them advance their cognitive, social and kinesthetic, and linguistic development.

Based on the above information, the study objective is outlined in the following main question:

How does the proposed unit based on the STEM approach affect the development of fundamental science processes among kindergarteners in Makkah Al-Mukarramah?

2.2. Study Objectives. This study aimed to achieve the following:

(1) Suggesting a STEM-based unit to develop basic science processes for kindergarteners in Makkah

(2) Clarifying how the proposed unit based on the STEM approach affects the development of basic science processes for kindergarteners in Makkah

2.3. Study Importance. This study's importance is highlighted in the following items:

(1) This study provides a new vision for kindergarten curriculum developers and planners to establish curricula based on the integrative STEM approach

(2) This study enriches the kindergarten curricula with a proposed unit based on the STEM approach, with the aim of developing basic science processes in children

(3) This study provides kindergarten teachers with modern strategies based on the STEM approach, including a procedural guide that can help them teach units in light of the STEM approac

(4) This study provides kindergarten teachers with various activities and illustrated tests to measure the degree of development that children achieve in basic science processes.

2.4. Study Limitations. This study was limited to the following:

(1) Objective limits: the proposed unit based on the STEM approach was designed to develop some basic science processes for kindergarteners in Makkah. The unit includes some basic science processes appropriate for kindergarteners (i.e., observation, classification, measurement, conclusion, and use of numbers).

(2) Temporal limits: this study was implemented during the first semester of the year (1443H).

(3) Spatial limits: this study was conducted at the Al-Ma'ali Governmental Kindergarten in Makkah.

(4) Human limits: this study was conducted among a sample of prekindergarten children aged between five and six years.

2.5. Study Terminology. In this study, the STEM approach was procedurally defined as including teaching and learning processes that focused on the integration of science, technology, engineering, and mathematics. This was accomplished by designing a proposed unit and providing an environment rich with activities, experiences, tasks, and projects that employed basic science processes through designs and innovative handmade products to solve simple life problems. The aim was to help develop basic science processes for kindergarteners.

In this study, the science processes were procedurally defined as the set of skills and mental processes that children acquired while practicing activities from the unit based on STEM introduction. The unit was designed to develop several mental processes, including observation, classification, measurement, conclusion, and number use. For each of these areas, development levels were measured by having the children take the illustrated test on specific science processes, which was prepared by the researcher.

2.6. Study Hypothesis. After reviewing the literature, referring to the relevant theoretical framework, and considering recommendations from previous studies, we established the following hypothesis:

There were no statistically significant differences ($\alpha \leq 0.05$) between the mean scores of children from the two applications (pre and post), as measured via the basic science processes test.

2.7. Theoretical Framework

2.7.1. First Topic

(1) Principles for Applying the STEM Approach in Kindergarten. Dubosarsky et al. [17] provided a set of guidelines for high-quality STEM experiences in the kindergarten classroom, as found in the following points:

(1) Developmental suitability: STEM Learning Experience Essentials provides children with books, videos,

materials, and tasks that are appropriate for their cognitive and language development.

(2) Cultural suitability: the basics of STEM learning experiences are designed to reflect cultural diversity regarding the learner's gender, environment, and physical abilities by considering and emphasizing children's cultural privacy.

(3) Application of the engineering design process: STEM learning experiences engage children in creating multiple, open-ended solutions to problems that require them to follow the engineering design process, including asking (what is the problem), imagining (brainstorm), planning, executing, and testing, doing a good job, and communicating (offer the work).

(4) Integrity of academic content: the learning experiences of the STEM Foundations are accurate contents that reflect the standards and basic skills relevant to the fields of science, technology, engineering, and mathematics, as described in the standards and frameworks of the stage.

(5) Quality of technology integration: the basics of STEM learning experiences are practical in nature and require children to use a variety of tools to solve each problem individually (e.g., scissors, hand lenses, scales, and computers).

(6) Links between STEM and other specialties: STEM Instructional Experience Essentials helps children connect STEM knowledge and skills with standards from early technical, social, emotional, and physical education.

(7) Real-world connections and professions related to STEM domains: fundamentals of STEM learning are stimulated through real-world phenomena that are familiar and relevant to children's lives, both in and out of the classroom. When applied, high-quality learning experiences in science, technology, engineering, and mathematics offer various career opportunities in these fields. This helps children achieve a clearer understanding of the roles individuals take when working in these disciplines.

(8) Nature of assessment: the STEM modules include inline formative assessments and inline summative assessments. The variety of activities allows children to demonstrate their understanding in different ways. This also allows teachers to record better learning outcomes.

The engineering design process is the basis of engineering in STEM. It is organized into steps to design products that meet human needs and desires and/or solve life problems. It also emphasizes the importance of using some studies in the field during the kindergarten stage, including Bagiati and Evangelou [18] and Aldemir and Kermani [19]. In this study, the engineering design process steps were represented through pictures and simple words suitable for kindergarteners. Therefore, the children were familiarized with steps and used them in product design for STEM entrance.

2.8. Field Study Procedures

2.8.1. Study Approach. This study adopted a descriptive-analytical approach to reach appropriate basic science processes for kindergarteners and prepared a proposed unit based on the STEM approach as well as a test on basic science processes.

Furthermore, this study required the use of experimental methods with a quasiexperimental design. This method is appropriate for revealing the impact of the independent variable (a proposed unit based on an entrance) STEM on the dependent variable (basic science processes); therefore, the experimental method with quasiexperimental design based on a single group was used to test the validity of the hypothesis.

2.8.2. Study Community. The study community is represented by all preschool children enrolled in government kindergartens of the Ministry of Education in the city of Makkah (4,338 children) during the first semester of academic year 1443H.

2.8.3. Study Sample. One classroom of the third preparatory level classes (five to six years) was randomly chosen by lottery. It had 30 boys and girls. The number of sections (three) and an introductory section (A) were chosen. The study materials and tools were applied to this sample.

2.9. Study Tools and Research Material

2.9.1. First: Study Material. Construction of a proposed unit is based on the STEM approach.

2.9.2. Second: Study Tools

(1) Proposed Test on Basic Science Processes in Kindergarteners (Prepared by the Researcher). The nature of this study required preparing a pictorial test aimed at measuring the degree of development of basic science processes among kindergarteners, including the following: observation, classification, measurement, inference, and the use of numbers. It further helped reveal the effect of the proposed unit based on the STEM approach in the development of basic science processes for kindergarteners by allowing for a comparison of differences between the average scores of children on the pre- and metatest.

(i) Description of the proposed test on basic science processes for kindergarteners (structure and vocabulary configuration): this study chose to implement an objective multiple-choice test, as presented in the form of questions followed by a number of alternatives (pictures and words), one of which represented the correct answer. The children chose an answer by drawing a circle around it. There were 20 test items.

(ii) Instructions for the proposed test on basic science processes for kindergarteners: the test was applied on an individual basis. The teacher sat with each child individually, read the questions and accompanying sentences, and explained the answering procedure as required by the question.

(iii) Correction proposed test of basic science processes for the kindergarteners: the children were given one point for a correct answer and zero points for an incorrect answer.

(iv) Validating the proposed test on basic science processes for kindergarteners: the test was measured for validity by presenting it in its initial form to a group of specialized arbitrators comprised of faculty members from Umm Al-Qura University and other universities. A number of kindergarten teachers and directors expressed their opinions on the clarity of the questions and rated their suitability, both in relation to the relevant processes and for use among children. They gave their opinions on the following: achieving the study objectives, evaluating the level of linguistic formulation, clarity of images, output, and any observations they deemed appropriate with regard to modification, change, or deletion. Based on the observations of the arbitrator professors, some questions were modified. Some images were changed due to their lack of clarity and unsuitability for the Saudi environment. Thus, the test of basic science processes achieved the so-called apparent sincerity or sincerity of arbitrators.

(v) Experimental application of the proposed test on basic science processes for kindergarteners via survey sample: the test was applied to an exploratory sample consisting of 20 children from Al-Ma'ali kindergarten, all of whom were selected independently of the study sample. After this application, the following was calculated:

(vi) Time of the proposed test on basic science processes for kindergarteners: the test time was calculated based on the average response time of all children in the exploratory sample. The test time was 25 minutes for each child, according to the following equation:

$$\text{Test time} = \frac{\text{Total time spent by each of the children in the exploratory sample}}{\text{Total number of the survey samples}}. \quad (1)$$

(vii) The difficulty and ease coefficients of the basic science processes test questions: based on the results of the exploratory experiment, the difficulty coefficient of the test questions was calculated as the percentage of those who answered the question correctly by applying the following equation:

$$\text{Difficulty coefficient} = \frac{\text{Number of children who answered the question correctly}}{\text{Total number of the survey sample}}. \quad (2)$$

The coefficient of ease was the opposite of the coefficient of difficulty, as calculated according to the following modulus:

$$\text{Ease coefficient} = 1 - \text{Difficulty Coefficient}. \quad (3)$$

Table 1 shows the difficulty and ease coefficients for the basic science process test questions.

As shown in Table 1, the difficulty coefficient values for all basic science process test questions were statistically acceptable. According to Al-Kilani et al. [20], the ideal difficulty coefficient is between 0.30 and 0.70. The values of the difficulty factor for the basic science process test questions ranged from 0.35 to 0.58.

(i) The discrimination coefficient for the proposed test on basic science processes for kindergarteners: the coefficient of discrimination was calculated through the following steps:

(1) The children's results from each question were arranged in descending order.
(2) According to their results on each question, the children were divided into two groups, high (50%) and low (50%).
(3) To calculate the coefficient of discrimination for objective questions (which had scores of zero or one), we applied the following equation:

$$\text{Discrimination coefficient} = \frac{\begin{pmatrix}\text{total of thos ewho answered the question correctly from the upper category} - \\ \text{total of those who answered the question correctly from the lower category}\end{pmatrix}}{\text{Number of one of the two groups}}. \quad (4)$$

Table 1: The difficulty and ease coefficient of the basic science process test questions.

S	Difficulty coefficient	Ease coefficient	S	Difficulty coefficient	Ease coefficient
1	0.35	0.65	11	0.55	0.45
2	0.55	0.45	12	0.45	0.55
3	0.50	0.50	13	0.40	0.60
4	0.40	0.60	14	0.35	0.65
5	0.55	0.45	15	0.35	0.65
6	0.45	0.55	16	0.45	0.55
7	0.52	0.48	17	0.45	0.55
8	0.58	0.42	18	0.40	0.60
9	0.45	0.55	19	0.40	0.60
10	0.35	0.65	20	0.50	0.50

Tables 2 and 3 show the results of the discrimination coefficient for the basic science process test questions.

Table 3 shows that the discrimination coefficient values for the basic science process test questions are statistically acceptable. According to Abu Daqqa [21], the acceptable coefficient of discrimination is between 0.30 and 1.00. The discrimination coefficient values for the basic science process test questions ranged from 0.50 to 1.00.

(ii) Internal consistency validity of the basic science process test: we calculated internal consistency validity for the basic science process test, specifically by calculating the Pearson correlation coefficient between the degree of each operation and total score. Table 4 shows the results.

Table 4 shows that the correlation coefficient between the degree of each operation and the total score for testing the basic science process test was statistically significant (<0.01). This indicates that the skills were consistent and suitable for application across the study samples.

(iii) Reliability of the pictorial basic science process test for kindergarteners: the reliability of the basic science process test was calculated via the following:

(1) Couder-Richardson equation 20 (KR-20) was implemented because it is more common for questions wherein scores of one and zero are given for correct and incorrect answers, respectively:

$$KR - 20 = \frac{N}{N-1} \times 1 - \frac{(\text{Total}\, S \times K)}{A}, \quad (5)$$

(2) whereas N = number of test items and A = total variance of the test.
(Total $S \times K$) = percentage of correct answers × percentage of wrong answers of individuals. Table 5shows the reliability results.
Table 5 shows a reliability coefficient of 0.786 for the test on basic science processes, according to the Couder-Richardson equation 20 (KR-20). This indicates that the test has an appropriate degree of reliability and homogeneity. For example, Abu Hashem [22] reported that reliability coefficients >0.60 are statistically acceptable.

(3) Cronbach's alpha equation: Table 6 shows the reliability results from this procedure.

Table 6 shows that the test on basic science processes achieved a reliability coefficient of 0.794 (Cronbach's alpha). This indicates that the test on basic science processes has an appropriate degree of reliability and homogeneity. For example, Abu Hashem [22] reported that reliability coefficients >0.60 are statistically acceptable.

The final form of the basic science process test: the test instructions and paragraphs were reviewed based on the exploratory experiment's results. Next, necessary modifications were made to get the final form. The test included 20 multiple-choice questions, which is the highest degree (20 in 20 pages). The answers were in the same test booklet, such that the children were given one point for a correct answer and zero for an incorrect answer (see Table 7).

3. Results and Discussion

3.1. Study Application Procedures. The field study was conducted after the study materials and tools were prepared and verified for validity and reliability.

3.1.1. Presentation, Discussion, and Interpretation of the Study Results

First: presenting results related to the answer to the first question.

The text of the first question: what is the image of the proposed unit based on STEM entrance that aims to develop some basic science processes for kindergarteners in Makkah?

The first question was answered by reviewing relevant information from the literature, including previous studies related to the design of educational units based on STEM entrance and books of educational units approved for kindergartens in the Kingdom of Saudi Arabia. Such benefits were considered when designing the proposed unit.

Table 2: The arithmetic coefficients to extract the discrimination coefficient for the basic science process test questions.

True	False	Total	Difficulty	Max.	Min.	Max.-min.	One of the two groups	Discrimination
7	13	20	0.35	7	0	7	10	0.70
8	12	20	0.40	8	0	8	10	0.80
9	11	20	0.45	9	0	9	10	0.90
10	10	20	0.50	10	0	10	10	1.00
11	9	20	0.55	10	1	9	10	0.90
12	8	20	0.60	10	2	8	10	0.80
13	7	20	0.65	10	3	7	10	0.70

Table 3: Discrimination coefficient for basic science process test questions.

S	Discrimination coefficient	S	Discrimination coefficient
1	0.70	11	0.90
2	0.90	12	0.90
3	1.00	13	0.80
4	0.80	14	0.70
5	0.63	15	0.70
6	0.70	16	0.90
7	0.63	17	0.90
8	0.50	18	0.80
9	0.90	19	0.80
10	0.70	20	1.00

Table 4: Pearson's correlation coefficient between the degree of each (operation) and the total score for the basic science process test.

Science processes	Number of questions	Correlation coefficient
Note	4	0.791**
Category	4	0.784**
Measurement	4	0.775**
Conclusion	4	0.791**
Numbers	4	0.829**

**It is statistically significant at a significance level less than 0.01.

Table 5: The reliability coefficient of the test of basic science processes with the Couder-Richardson equation 20.

N	Total $S \times K$	A	KR-20
16	4.843	18.411	0.786

Table 6: Reliability coefficient of basic science process test with Cronbach's alpha equation.

N	Cronbach's alpha
20	0.794

Table 7: Distribution of vocabulary test for basic science processes.

Basic science processes	Number of vocabulary	Vocabulary no.
Note	4	1-2-3-4
Category	4	5-6-7-8
Measurement	4	9-10-11-12
Conclusion	4	13-14-15-16
Using numbers	4	17-18-19-20

Third: presenting results related to the answer to the second question and verifying the study hypothesis:

Fifth: presenting results related to answering the second question and verifying the study hypothesis. The text of the second question: how does the proposed unit based on the STEM approach affect the development of basic science processes for kindergarteners in Makkah? To answer this question and reveal the impacts of the proposed unit based on the STEM approach in the development of basic science processes among kindergarteners in Makkah, the following study hypothesis was tested: "There will be no statistically significant differences ($\alpha \leq 0.05$) between the mean scores of children from the two applications (pre and post), as measured via the basic science process test." This hypothesis was validated using the paired samples test. Table 8 shows the results.

Table 8 shows the following evidence:

For observation, the preapplication arithmetic mean of the children's scores on the basic science process test was 0.83, while the postapplication mean was 3.20. For classification, the preapplication arithmetic mean of the children's scores on the basic science processes test was 3.07, while the postapplication mean was 11.17. For measurement, the preapplication arithmetic mean of the children's scores on the basic science processes test was 1.47, while the post-application mean was 3.73. For conclusion, the pre-application arithmetic mean of the children's scores on the basic science processes test was 0.40, while the post-application mean was 3.77. For the use of numbers, the pre-application arithmetic mean of the children's scores on the basic science processes test was 1.27, while the post-application mean was 3.73. Finally, the total pre-application arithmetic mean of the children's scores on the combined basic science processes test was 7.03, while the post-application mean was 25.60.

Table 8 also shows that statistically significant differences existed between the average scores of children in the two applications (pre and post) on the basic science process test. As all values from the t-test for all processes were statistically significant (<0.05), these differences were in the direction of the dimensional application with the highest arithmetic mean.

For tested kindergarteners in Makkah, these results show that the proposed unit based on STEM positively affected the development of the following basic science processes: observation, classification, measurement, deduction, and numbers. This rejected the null hypothesis and supported the alternative hypothesis, as follows: "there are statistically significant differences ($\alpha \leq 0.05$) between the average scores of children in

Table 8: The differences between the mean scores of children in the two applications, pre and post, of the basic science process test.

Science processes	Application	No.	SMA	Standard deviation	Degree of freedom	T value
Note	Pre	30	0.83	0.986	29	12.970
	Post	30	3.20	0.664		
Category	Pre	30	3.07	1.680	29	25.087
	Post	30	11.17	1.315		
Measurement	Pre	30	1.47	1.252	29	9.468
	Post	30	3.73	0.583		
Conclusion	Pre	30	0.40	0.563	29	21.684
	Post	30	3.77	0.504		
Numbers	Pre	30	1.27	1.015	29	13.403
	Post	30	3.73	0.521		
Whole test	Pre	30	7.03	3.439	29	36.160
	Post	30	25.60	2.343		

Statistical significance level = 0.000.

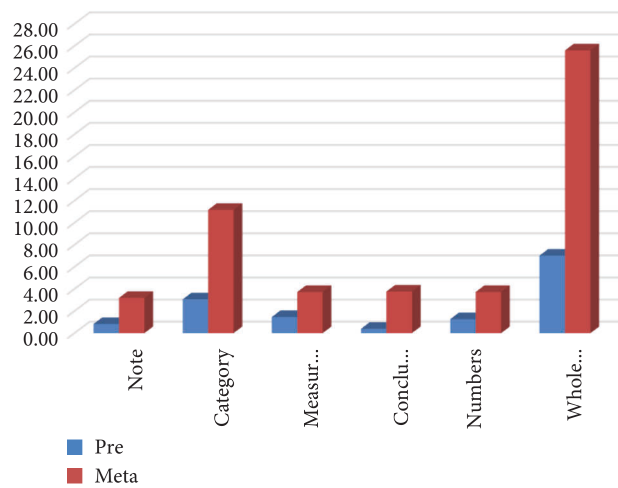

Figure 1: Arithmetic averages of children's scores in the two applications, pre and post, to test the basic scientific processes.

Table 9: The size of the impact of using the proposed unit based on the STEM approach in developing some basic science processes.

Concept	Pre	Meta	Difference between the two means	T value	Sample	Standard deviation	d	Effect
Note	0.83	3.20	2.37	12.970	30	0.999	2.37	High
Category	3.07	11.17	8.10	25.087	30	1.768	4.58	High
Measurement	1.47	3.73	2.27	9.468	30	1.311	1.73	High
Conclusion	0.40	3.77	3.37	21.687	30	0.850	3.96	High
Numbers	1.27	3.73	2.47	13.403	30	1.008	2.45	High
Whole test	7.03	25.60	18.57	36.160	30	2.812	6.60	High

Table 10: Influence magnitude classification.

Weak effect	0.20	Medium effect	0.50	Strong effect	0.80

the two applications (pre and post), as measured via the basic science processes test." Figure 1 illustrates this result.

Figure 1 shows that the difference between the arithmetic averages of the children's scores in the two applications (pre and post) were examined for the following basic science processes: observation, classification, measurement, conclusion, the use of numbers, and total. Cohen's equation (d) was used to clarify the impacts of the proposed unit based on the STEM approach in developing basic science processes for kindergarteners in Makkah. Table 9 lists the results.

Based on the results shown in Table 9, the proposed unit based on the STEM approach was characterized by a high impact size of the development of basic science processes for kindergarteners in Makkah. According to Cohen [23], a strong effect exists when d values are greater than 0.80. This demonstrates a high influence magnitude, as outlined in the following classification (see Table 10).

The previous presentation of results pertaining to the study hypothesis led us to answer the second study question.

The proposed unit based on the STEM approach positively affected and played an effective role in the development of basic science processes for kindergarteners in Makkah. This was evident through the statistical treatment used.

The impact of the STEM-based unit in developing basic science processes for kindergarteners can be explained through the following considerations:

Children had positive roles in the proposed STEM-based unit. They thought, asked, and discussed and then performed multiple mental processes (e.g., observing, categorizing, measuring, deducing, and using numbers) while completing experiments and activities. In this context, they gained knowledge by practicing various scientific processes. Through direct contact with the learning environment, they achieved meaningful knowledge by understanding and developing basic science processes.

4. Conclusions

4.1. Summary of Findings, Recommendations, and Suggestions

4.1.1. First: A Summary of the Study Findings

(1) This study implemented a list of basic science processes appropriate for kindergarteners.

(2) This study constructed a proposed unit based on the STEM approach, with the aim of developing basic science processes in kindergarteners.

(3) There were statistically significant differences between the average scores of children in the pre- and postapplications of the basic science process test. All t-test values for all processes were statistically significant (<0.05); these differences were in the direction of the dimensional application with the highest arithmetic mean. Therefore, they indicated that using the proposed unit based on the STEM approach positively impacted the development of the following basic science processes: observation, classification, measurement, conclusion, and the use of numbers among kindergarten children in Makkah. Moreover, the use of the proposed unit based on STEM entrance was characterized by a high impact size in the development of basic science processes across the study sample, with all d values exceeding 0.80.

4.1.2. Second: Recommendations

(1) Qualified personnel should hold training courses with kindergarten supervisors. They should introduce the importance of the STEM approach, describe how it should be employed in the daily kindergarten context, provide references and resources that raise training efficiency, and explain the application method.

(2) Inviting individuals who are in charge of planning and developing educational units in kindergartens to understand the necessity of developing these units in light of the STEM approach. Enriching them with basic science processes appropriate for kindergarten children, as reached in this study.

(3) Activating community partnerships with scientific STEM centers to highlight the importance of the STEM approach, clarifying its application at the kindergarten stage, and exchanging field visits for teachers and children.

(4) Creating a relevant educational environment in kindergartens, enriching the children with appropriate educational materials and tools that help them activate the STEM approach, and developing basic science processes.

4.1.3. Third: Suggestions

(1) Conducting studies to evaluate the effectiveness of the STEM approach; focusing on the development of different variables, including problem-solving skills, creative thinking, and 21^{st}-century skills for kindergarteners.

(2) Conducting evaluation studies on the educational units prescribed in kindergartens to determine the extent to which they include scientific concepts and basic science processes appropriate for kindergarteners.

(3) Clarifying the effectiveness of a proposed training program based on STEM entrance for kindergarten teachers. Investigating how it influences different variables.

(4) Clarifying the realities of applying the STEM approach in the educational field in kindergarten. Investigating the difficulties that teachers face when applying this approach. Next, submitting evidence to competent authorities who can help overcome those difficulties.

Data Availability

For the privacy of participants, the data cannot be shared.

Conflicts of Interest

The author declares no conflicts of interest.

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