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The Effectiveness of Teaching Algebraic Principles through Sensory Activities in Kindergarten

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Since algebraic thinking is one of the foundational ideas for the development of algebraic thinking in young children, algebra has a crucial place in the area of mathematics and is one of the essential disciplines whose skills are necessary to be gained by all students from kindergarten to secondary school. This study was designed to prepare sensory exercises that align with algebra requirements, in order to stay up with the scientific advancements of youngsters in Egypt and Kuwait. In order to teach kindergarten students the fundamentals of algebra, the researchers developed a series of sensory activities that were based on both the standards for kindergarten mathematics instruction and the standards for learning the algebraic principles necessary for the stage of the study that was discussed. A test was also devised as part of the study to confirm the efficacy of those interventions. The findings statistically demonstrated the effectiveness of the suggested activities in helping the study sample's kids acquire the standards necessary for understanding algebraic principles—that is, what they need to know to move on from foundational problems and continue learning mathematics with confidence.

Keywords: principles of algebra, sensory activities, kindergarten, early childhood, teaching

INTRODUCTION

Among the branches of mathematics at all educational levels, algebra is indispensable. This is stated in the Conference of Mathematics Teachers NCTM, 2000, as one of the initial standards for the goals of the mathematics content areas, which include mathematical probability, data analysis, algebra, geometry and measurement, and numbers and operations on them. Pupils from early childhood education to the conclusion of high school, in order to benefit from 21st-century abilities. Teachers feel that the algebraic practices and exercises we offer, along with the problem-solving opportunities they present, are more quantitative and qualitative than anything else in

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the curriculum. They form the foundation for work in chemistry and physics and are differentiated from geography, history, and the English language. need a solid algebraic basis (Tami, 2001; Baeker, 2002; Purpura, et al., 2016; Nina, A., et al., 2021; Een Yayah, E.; Yanzi, H.; Drupadi, R. 2021 & Wawan, 2018). Youngsters who study algebra gain symbolic experiences that help them interact with other subjects, like music and the arts. They arrive at the mathematical format when they have mastered patterns of various colours and are familiar with melodies and musical linkages (Leeming, 1999, Burker, 2000, Purpura, et al. 2011, Purpura, et al. 2016, Umbara, U., Munir, S. & EFW Puadi, 2021).

The majority of Egyptian schools focus their educational efforts primarily on teaching students the bare minimum of the "Bloom" educational goals—memorization and memorization—despite the significance of this goal and the need to work towards achieving it. This has resulted in a sharp decline in students' mathematical proficiency. The abilities necessary for studying algebra are generally not included in kindergarten mathematics curricula, which results in a reduction in such skills. Algebra is a method of reasoning. It is predicated on the capacity to employ a range of techniques that facilitate fruitful algebraic expression. Problems arising from the representation of functions, abstraction from calculations, and various modes of operation of the mind can all be solved by algebraic thinking. This is taught to preschoolers (ages 4–7) using sensory-based activities that help them practise using algebraic reasoning. In 2018—Ralston and Taylor. Precise concept organisation is necessary for algebra, which is a fundamental mathematical skill that teaches kids how to solve problems (Somasundaram, P. 2021). In addition to making them feel satisfied, it teaches them the perseverance and logical thinking needed to solve even the most difficult mathematical puzzles. This encourages them to learn other subjects that call for a strong background in mathematics down the road (Susan et al., 2011, Deborah et al., 2009), and it incorporates algebraic thinking in many situations. It is frequently the process of generalising mathematical operations, and as they get more sophisticated, it deals with more and more unknown numbers. Teachers must carefully guide students towards algebraic thinking, which involves the process of generalising arithmetic operations in a more complex way, where they will be dealing with unknown and unexplicit quantities, when it comes to finding patterns and mathematical generalisation (NCTM, 2000, Schiemann, et al 2013, Radford, 2015, Stephens et al. 2015 & Somasundram, P. 2021). The aforementioned highlights the significance of kindergarteners gaining kindergarten-related math skills, continuing their education, and avoiding challenges that are not yet established as these could result in low self-esteem and a dislike of broader math topics; It is especially necessary to pay no attention to the mathematical standards related to algebra learning as one of the important branches of mathematics and seriously try to put forward a series of sensory activities that help in gaining many experiences in various fields, given the dearth of education and algebra learning in the field of Arab studies, aside from the obvious shortcomings in the curriculum. This is why the current study set out to create a series of sensory life activities based on kindergarteners' mathematical understanding, which align with the requirements for teaching them the fundamentals of algebra.

LITRETURE REVIEW

For the children in the research sample, algebra is a fundamental and significant requirement. The topics that make up this group of topics reflect the importance of algebra and should be developed to meet international standards for mathematics education and align with current development movements. According to the Conference of Teachers of Mathematics (NCTM, 2000) document, algebra should be taught in mathematics curricula related to patterns and relationships for students in kindergarten through fourth grade (KJ1-4). This will enable students to recognise, characterise, and generate a variety of patterns as well as represent and explain relationships. mathematics, and investigates how variables are used to represent ideas and even build relationships. Algebra is crucial in children's lives, according to Mosses, B. 1997 and Widya, et al., 2022, for the following reasons: The first step towards the upper levels of the specialisation is algebra. The fundamental logic of many mathematical areas is algebra. (Adamuz-Povedano, N., Fernández-Ahumada, E., Teresa García-Pérez, M., & Montejo-Gámez, J. (2021). Higher education achievement is correlated with algebraic skills. The acquisition of abstract skills related to algebra by the child facilitates the mastery of abstract thinking and enhances his capacity to create and evaluate coherent articles, so enhancing his overall thinking abilities. The main tools of algebra are symbolism and abstraction, whereas children make use of symbols to comprehend a variety of quantities. Additionally, it emphasises the significance of these kids gaining algebraic skills, which in their context provide them abilities that help them in all of the above, as well as the ability to work through related concepts to reach generalities and to create predictions by revealing and interpreting models. The ability to analyse ideas and issues, precisely define problems and solve them, derive conclusions from the premises, achieve accuracy in obtaining information and data, apply the rules of logical inference in different situations, make decisions, and understand, synthesise, and interpret logical issues are among the many life skills that early algebraic education imparts to young children (Champman, 1998, Warren, 2004; Susan, R., Deborah, S., Virginia, B. 2011; Iskander S. et al., 2021; Somasundram, P. 2021; Billion, L., Huth, M., 2023 & Reikerås, E. 2023).Chui, H., Chin, H., Wan, B. (2024)

The importance of sensory activities in teaching children the principles of algebra

Because preschoolers are still in the pre-operational stage (4–7), which is when learning concepts and experiences is mostly done through the senses, it is the reason why these children are unable to grasp the fundamentals of writing and reading. By addressing mathematical problems in a context that is relevant to their environment and everyday lives, a series of activities can help children develop their algebraic math skills. Children's interest is piqued, the educational process and their knowledge are enriched, they are given the chance to interact with the material, and the content is made engaging by adding a variety of educational activities that cover various branches of mathematics. This increases the students' desire to study, love, and innovate in mathematics. The sources include Dörfle (2006), Billion, L. 2021, Nina, A. et al 2021, and Widya, K. et al 2022). Early pre-teaching experiences for students set the stage for algebraic thinking (Eriksson, H., & Eriksson, I. (2021). They are a widely underutilised tool for helping pupils in the classroom strengthen their algebraic thinking Chimoni, M., & Pitta-

Pantazi, D. (2017). These are mental tools gleaned via a variety of encounters with the outside world. Examples show how early childhood experiences can plant the seeds of algebraic thinking. Examples also show how children's engagement in algebraic thinking processes varies according on the relationship between their early activities. Learning algebra through activities such as card games, dice, photography, painting, and colouring is a valuable way to use multiple senses in order to convey mathematical concepts visually. In order to solve a number of issues that young children encounter, Bell, 1998 & Piaget highlighted the value of employing sensory activities like puzzles, handicrafts, and cutting cubes. These activities follow a logical path from the tangible to the semi-tangible, until it reaches the stage of abstraction. Additionally, children five years of age and up might understand the concept that represents a property or a set of abstract properties, as well as the idea of abstraction, which is connected to algebra and arithmetic (Deborah et al. 2009, Iskander S. et al., 2021 & Reikerås, E. 2023). Early childhood pre-teaching experiences lay the foundation for algebraic thinking and are a generally underutilised resource in the classroom for encouraging students to think algebraically. (Radford, L. (2014). These are mental tools gleaned via a variety of encounters with the outside world. Examples show how early childhood experiences can plant the seeds of algebraic thinking. Examples also show how children's engagement in algebraic thinking processes varies according on the relationship between their early activities. For the visual sensory representation of mathematical concepts, it is important to use several senses when learning algebra through activities such as card games, photography, painting, and colouring (Puter, 1998 & Bell, 1999). In order to solve a number of issues that young children encounter, Piaget stressed the value of employing sensory activities like puzzles, handicrafts, and cutting cubes. These activities follow a logical path from the tangible to the semi-tangible, and ultimately to the stage of abstraction. Additionally, children who are five years old and older may understand the concept that represents a property or a set of abstract properties as well as the idea of abstraction, which is connected to algebra and arithmetic (Deborah et al., 2009, Umbara, U. et al., 2021 & Arnawa et al., 2021).

Kindergarten children learn the principles of algebra

Despite being a challenging topic, algebra requires a solid understanding of a number of mathematical concepts covered in middle and high school, including complex multiplication, the long attribute, and other mathematical criteria. However, a youngster as young as five or six years old can understand the fundamentals of algebra when they are given the necessary foundations. This way, when the child reaches higher educational levels and is exposed to more difficult algebra, they won't be terrified of unknown equations and symbols. Despite algebra's significance as a kindergarten requirement, the standards related to it were excluded from the Ministry of Education's plan to teach students mathematical concepts in the course content, with the exception of a few objectives that included exposure to patterns in passing and both quantitative and qualitative expressions. Without concentrating on its content, it is inside the framework of numerical concepts. Instead of being brainwashed, children learn algebraic concepts and principles through experimenting (Tami & Widya, et al., 2022, Reikerås, E. 2023)

$$\text{If} \quad X = 5Y \quad \text{Then} \quad 2X = 5\,Y + 5\,Y$$

The writers equalised the scales using the concept of a basic scale to illustrate the idea of equality between various items, including bananas and grapes, and to impart algebraic concepts. Although learning the addition, subtraction, multiplication, and division operations is necessary for algebra, children's lack of proficiency in these areas makes it difficult for them to learn algebra. This is a significant barrier to mastering the algebraic ideas connected to these high arithmetic abilities. Understanding patterns, relationships, type, classification, measuring sizes, number skills, the capacity to form patterns in a sequence of basic numerical shapes and patterns, using concrete numbers, comprehending symbolic notation, and using mathematical models are all critical for kindergarten algebra, according to Usiskin, E. (1999). to analyse change in qualitative and descriptive contexts, as well as to comprehend quantitative relationships through addition, subtraction, and the use of pictures, symbols, and figures. Heaton, R. (1999) studied a sample of preschoolers (KJ2) and first-graders in primary school to acquire algebraic skills. The study's findings showed that improving the skills under investigation had a statistically significant impact on raising the performance rate in science and mathematics overall. Maldonads, S. (1999), Stephens, A. et al. (2015) studied second-grade kids (KJ2) with the same objective in mind, attempting to determine the impact of utilising mathematical games such magic squares and numerical puzzles on the algebraic abilities associated with patterns for kindergarten. The outcomes demonstrated how well the exercises worked to improve the algebraic pattern-related competence. Despite this, NCTM (2000) provided the following summary of the Standards for Teaching Algebra to Kindergarten KJ2 Children: (1) Recognise patterns, relationships, and functions; (2) Use algebraic symbols to express and analyse mathematical situations and structures; (3) Use mathematical models to represent and comprehend quantity relationships; and (4) Analyse changes in several contexts simultaneously.

While teaching algebra to kindergarten students, Chapman, M. (1999) provided training to a group of pre-service teachers on some direct learning tactics for mastering the concepts of patterns, comprehending relationships, and streamlining the idea of functional relevance. The outcomes demonstrated how well the training helped teachers pick up strategies for honing these abilities. In order to achieve mathematical communication, Saenz, L. 1999 & Elfiky, D. 2022 seek to identify the obstacles that prevent kindergarten teachers from imparting to third-level students the skills related to symbols and the relationship of equality between them. They also seek to determine the causes of these obstacles and create a therapeutic vision that will help the study sample overcome these obstacles. In order to achieve mathematical communication, Saenz, L. (1999) outlined the challenges that kindergarten teacher’s face when attempting to teach third-level students the concepts of symbols and their equality. She also identified the factors that contribute to these challenges and created a remedial plan to help the study sample get past them. A consensus was achieved on strategies to improve learning environments by incorporating mechanisms that teach kids symbolic education-related abilities, help them solve coding challenges, and meet the academic requirements for fostering kids' critical thinking. In order to provide children with the fundamentals of algebra and enhance their comprehension of quantitative relationships, Carpenter, L. & Carey, D. 1999, Kulm, 2000, Sarah, P. 2014, & Reikerås, E. 2023 used manual

materials activities to reveal how children learn concepts. These activities also revealed the requirements for developing algebraic thinking in children as well as the methods and applications that help them move from arithmetic thinking to algebraic thinking. Simultaneously, some research has found that the challenge of teaching mathematics and algebraic thinking is associated with the challenge of thinking that has been passed down to them from earlier generations (Sara, P. 2014). To learn more about the standards for improvement that could help in-service and pre-service educators who are having trouble teaching algebra, An experimental design strategy was utilised by Karina & Doug (2015) to assist teachers in avoiding the challenges they have when teaching algebra. Teachers can also learn about students' algebraic thinking strategies and conceptual depth by using evaluations (Nicole & Catherine, 2018, Iskander, et al., 2021, Billion, L. 2021 & Billion, L, Huth, M. 2023). Mariana & Janet, 2022 provide numerous examples of early childhood children interacting with the outside world prior to teaching experience, so supporting the premise that childhood is the fundamental early period for learning to think at its various levels and kinds of instruction.

Research Problem

Not a single Arab study has concentrated on this topic in kindergartens, despite what was previously stated in the introduction to this research on the significance of algebra and the abilities linked with it, as well as the necessity of giving these skills to learners at all levels of school. After looking at numerous studies, conferences, and pedagogues interested in teaching mathematics to young Arab students, the researcher was able to confirm that there is a glaring gap in the area of algebra instruction, which is an important educational objective in the age of digitalisation. The researcher also observed that kindergarteners had trouble comprehending what equality meant. The equal sign is only used to indicate a tie in quantity and quality (4 red roses = 4 white flowers), and as a result they are unable to comprehend equality in terms of time, weight, height, etc. This is what inspired us to plan and create sensory experiences that serve as conceptual explanations of equality. The foundational mathematical abilities of algebra are essential. As a result, research is a crucial component of the field of children's mathematics, as recommended by the Conference on Mathematics Education NCTM, 1999, 2000, and numerous studies (Moses, B. 1997, Burker, M. 2000, Tami, L. 2001, Backer, A. & Lemon, L. 2002, Russell, J et al, 2006, Oksuz, O. 2007, Schliemann, et al, 2013, Stephens et al. 2015 & Billion, L. & Huth, M. 2023... and others) on the significance of the field of research today in preparing Arab children for lifelong learning and to The following enquiries are the focus of this study:

1. For what algebraic concepts are the most crucial standards that young children should learn how to solve them?

2. In what ways might sensory activities be created to equip the research sample of preschoolers with the algebraic abilities they need?

3. To what extent do these activities help the research sample of preschoolers develop the mathematical abilities needed to meet algebra standards?

Because there is a dearth of research on the subject of teaching algebra to children at the Arab and local levels and because algebra curricula in Egypt and Kuwait have not been successful in teaching children mathematics since 2000, this has prevented the field from meeting the needs of contemporary development, and which the study sought to address. For the benefit of the current study, a collection of international studies and research on the subject of teaching algebra to pre-schoolers, which represents the most significant contemporary trends in the field, can be used to develop math curricula for young children in the Arab World, from which the necessary algebra standards have been met, as demonstrated in Table 1:

Table 1
Algebra standards for grade KJ2

Standards	Objectives
1) Understand Patterns, Relations, and Functions.	• Classification, arrangement, and measurement of items according to their sizes and characteristicsإدراك • Description of easy and simple shapes: (sequences of sounds, shapes, and digital models). • Repeating & Growing Patters.
2) Represent and analyse Mathematical Situations and Structures Using Algebraic Symbols.	• Knowing the properties of things and the properties of operations (such as classifying and arranging numbers). • Using pictorial-linguistic methods to develop understanding of symbols (traditional and innovative).
3) Mathematical Models to Represent and Understand Quantities Relationships.	• Designing models that contain addition and subtraction of numbers using elements and symbols.
4) Analysis Change in Various Contexts.	• Able to describe qualitative changes. • Can describe quantitative changes.

Given the educational background mentioned above, the research has addressed the first issue posed by the problem: "What are the most important standards related to algebraic principles that pre-schoolers should be able to perform?"

Hypotheses

In order to address the study's second and third questions, the following theories were developed:

H1: "The results of testing sensory activities in algebraic principles through the associated criteria show statistically significant differences between the mean scores of the control group and the experimental group, favouring the pre-application of the research experiment at the level (0.001) of significance."

H2:"There are statistically significant differences at the level (0.001) of significance between the mean scores of the control group and the experimental group in the results of testing sensory activities in the principles of algebra through the associated criteria,

in favor of the post-application of the research experiment mean scores of the experimental group pupils".

H3:" The sensory activities used to provide the children of the experimental group of the research with the skills of principles of algebra at the post-school stage are effective in providing them with the skills targeted in the research".

METHOD

Since the experimental approach best fits the study's objectives, the research uses it to create algebra standards for the kindergarten students that make up its sample. It comprises of a series of sensory exercises that are to be performed on the experimental study sample, and an assessment was created to confirm the exercises' efficacy. In addition to the Smouha Experimental School, which represents the exploratory study group, the test was administered to a purposefully selected experimental sample of twenty-four children (by conscious selection from KJ2 level, five to six years) at the El-Khansaa Experimental School from the original community representing the kindergarten in Alexandria.

Research Tools

An algebraic skills exam designed for kids that incorporate sensory activities: The test's objective is to equip kids, who make up the research sample, with algebraic mathematical skills while using standards from the literature and earlier research that are incorporated into the research's theoretical framework.

Codification of the research tool

1) Test reliability: To make sure the sensory activities were suitable for the study sample, the test was given to sixteen arbitrators who are professors with expertise in curriculum and psychology in education and early childhood colleges. Some of the activities were changed or eliminated. After some adjustments and consideration of the arbitrators' opinions, it was decided that the test was appropriate for the intended use.

2) Test reliability: a) Cronbach's Alpha Reliability Coefficient: This measure of the intelligence test's reliability was determined by applying it to an exploratory sample. The test's Cronbach's Alpha reliability coefficient was then calculated, reaching (0.775).

b. Re-application Validity: coefficient: After administering the test to the exploratory sample, the reliability of the intelligence test was determined using the re-application Validity: coefficient. The test's overall re-application Validity: coefficient reached (0.814), a statistically significant Validity: coefficient at the significance level (0.01). As a result, the test has a high degree of validity, indicating that it may be used in the current research and that the results of the research will be valid.

Scale time: The test duration was determined by taking the average of the times it took the children who answered the questions the quickest and the children who answered them the slowest. As a result, it took 34 minutes to complete the test items, according to the calculation.

Preparing environmental sensory activities

This was accomplished by looking up earlier research and studies that were cited in the research references, as well as by analysing the mathematics curriculum recommended for kindergarteners in grade two (KJ2) to find out if there were any standards for teaching algebraic concepts. The behavioural goals of the activities and strategies were also established. The research will have addressed its second question, "Is it possible to design sensory activities to provide the research sample children with mathematical skills related to algebra standards for pre-school children?" by using educational methods, learning methods (Appendices 2 and 3), and organising the suggested activities (Appendix 1).

FINDINGS

H1: "The results of testing sensory activities in algebraic principles through the associated criteria show statistically significant differences between the mean scores of the control group and the experimental group, favouring the pre-application of the research experiment at the level (0.001) of significance."

The arithmetic mean, standard deviation, and "T" value were determined for the experimental and control research groups in order to confirm the validity of this hypothesis, as indicated in Table 2:

Table 2
The test's overall arithmetic mean, standard deviation, and "t" value, as well as their importance for the pre-measurement of the two research groups

The Group	Mean	Standard deviation	Standard error	T- Value	Significance level
Control Group	8.575	1.691	0.430	0.265	Not Significant
Experimental Group	8.689	1.179			

The previous table's "T" result, when compared to its tabular result, indicates that there are no statistically significant differences between the two research groups when it comes to the pre-application of evaluating a preschooler's sensory activities regarding algebraic concepts. This indicates that the research's initial hypothesis has been refuted, and the adoption of the alternative theory, which is anticipated prior to carrying out the suggested tasks.

H2:"There are statistically significant differences at the level (0.001) of significance between the mean scores of the control group and the experimental group in the results of testing sensory activities in the principles of algebra through the associated criteria, in favor of the post-application of the research experiment mean scores of the experimental group pupils".

To verify the validity of this hypothesis, the arithmetic means, standard deviation, and “t” value were calculated for the experimental and control groups in the skills test (Tables 3& 4).

Table 3
The mathematical mean, standard deviation, and "t" value, as well as their importance for the control group's post-measurement in the research variables connected to the pre-school algebra standards in the abilities test

M	Algebra Standards	Pree-test		Post-test		Stan-dared error	T value	Significance level
		M	S	M	S			
1	Understand Patterns, Relations, and Functions	2.851	0.855	3.108	0.845	0.251	1.025	Not Significant
2	Represent and analyze mathematical structures using algebraic symbols	2.125	0.577	2.333	0.576	0.176	1.023	Not Significant
3	Use mathematical models to represent and understand quantitative relationships	1.383	0.702	1.550	0.593	0.192	0.870	Not Significant
4	Analysis change in various context	1.997	0.576	2.167	0.498	0.159	1.070	Not Significant

According to the preceding table, there are no statistically significant variations in any of the math standards for preschoolers for the control research group, which was not subjected to the standards' experimental activities.

Table 4
The significance of the "t" value, the standard deviation, and the arithmetic mean for the post-measurement of the experimental group in the study factors related to the pre-school algebra standards in the abilities exam

M	Algebra Standards	Pree-test		Post-test		Stan-dared error	T value	Significance level
		M	S	M	S			
1	Understand Patterns, Relations, and Functions	2.916	0.756	6.242	0.763	0.224	14.857	Significant at 0.002
2	Represent and analyze mathematical structures using algebraic symbols	2.256	0.661	3.753	0.571	0.182	8.216	Significant at 0.002
3	Use mathematical models to represent and understand quantitative relationships	1.283	0.493	2.713	0.493	0.145	9.835	Significant at 0.002
4	Analysis change in various context	1.833	0.687	3.748	0.644	0.196	9.751	Significant at 0.002
	Total	8.689	1.179	16.456	1.320	0.369	21.465	Significant at 0.002

According to the preceding table, the experimental group's post-measurement results show statistically significant differences at the level (0.002) for the necessary algebra criteria. In light of the aforementioned, the prior hypothesis (H2) supporting the experimental group's post-application for the study was accepted. This is consistent with the findings of the following studies: Belt 1998, Buter 1999, Carpenter & Kulm 2000, David 2000, Meira, 2002, Karina & Doug. 2015; Een Yayah, E.; Yanzi, H.& Drupadi, R.2021, Nicole & Catherine. 2018 & Mariana, Arnawa, M., Ginting B.& Nita, S. 2021, Umbara, U. et al 2021 & Janet, 2022, Wawan, Heri Retnawati, 2022, Billion, L., Huth, M. 2023, Komariah, A. Wiyono, Rusdinal, B. & Kurniady, D.2023. Consequently, the study confirms that its second hypothesis is true.

H3:" The sensory activities used to provide the children of the experimental group of the research with the skills of principles of algebra at the pre-school stage are effective in providing them with the skills targeted in the research".

In order to confirm the correctness of this hypothesis, the experimental research group's post-test and pre-test measures in the goal standards for preschool algebra principles were altered using the "Black equation," as table 5 illustrates.

Table 5
Alterations in the experimental research group's post-test data from the pre-test and Black's adjusted gain ratio

M	Algebra standards	Max. limit	Post arithmetic mean	Pre arithmetic mean	gain ratio
1	Understand Patterns, Relations, and Functions	7	6.242	2.917	1.289
2	Represent and Analyze Mathematical Situations and Structures using Algebraic Symbols	4	3.753	2.256	1.232
3	Yuse Mathematical Models to Represent and Understand Quantities Relationships	3	2.713	1.213	1.310
4	Change in Various Context	4	3.748	1.833	1.363
	sum	18	16.48	8.689	1.266

The third hypothesis of this research is confirmed by Table (5), which displays the achievement of Black's modified gain percentage for each standard of the fundamentals of algebra for pre-schoolers. Additionally, this percentage exceeded the minimum limit for effectiveness, which is 1.2. The third question in the study, "What is the effectiveness of these activities in providing the children of the research sample with the mathematical skills related to the algebra standards for pre-school children?" has been addressed after the first, second, and third hypotheses have been proven to be true. According to research by Leeming, David (2000), Carpenter, M. (2003), Schemann et al. (2013), Karina & Doug (2015), Nicole & Catherine (2018), this is consistent. 2021, Billion, L. & Huth, M. 2023, Riekeras, E. 2023; Yanzi, H. & Drupadi, R. 2021, Janet, 2022, Widya, K. et al 2022, Arnawa, M., Ginting B.& Nita, S. 2021, Een Yayah, E. In summary, the findings demonstrated that the sensory exercises that were designed and

implemented had a beneficial effect on the experimental research sample's understanding of the fundamental algebraic concepts, which are outlined in Table (1) of the study and include: 1) Recognise Patterns, Relations, and Functions; and 2) Represent and Analyse Mathematical Situations and Structures Using Algebraic Symbols.3) Quantitative Models to Depict and Interpret Quantitative Relationships.4) Analysis Change in Various Contexts, to which numerous research previously mentioned as well as the NCTM conference made reference. The authors based their conclusions on the test's application to the study sample's children, which yielded results after statistical analysis of the kids' responses to the test items. These results showed statistical significance at acceptable rates, indicating the achievement of the research goal, which is to learn the fundamentals of algebra (Tables 2, 3, 4). The application of Black's equation to the responses provided by the children in the research sample revealed that the sensory activities had a positive educational influence, as evidenced by Table 5 data. This suggests that the research experiment was successful in reaching its objectives.

CONCLUSION

The study's findings suggest that kindergarten instructors should take pre- and during-work training sessions on how to explain algebraic concepts and related experiences to students using sensory activities that appeal to their six senses, like unconventional and tech-based games. This calls for the use of teaching strategies and methods (Karina & Doug., 2015) that enable students to comprehend algebraic mathematical thinking and assist them in gaining algebraic experiences derived from the standards included in numerous studies (NCTM, 2000) that comprise patterns, equality relations, numbers, and operations on them (Deborah, S., Russell, S., Bastable, V. (2009)); the use of mathematical models to comprehend quantitative relationships (Usiskin, 1999) and the understanding and analysis of relationships (Iskander S. et al., 2021)), as well as the sense of symbols. Algebraic thinking is linked to the quantitative understanding of mathematical relationships (Ralston & Taylor, 2018), and Purpura, DJ, & Reid, EE (2016)), as well as the symbolic sense (Ralston, NC, Li, M., & Taylor, C. (2018)) to understand the experiences of arithmetic, and the reference here to the significance of the small number associated with mental arithmetic because of its impact on understanding algebraic relationships (Stephens, A.,& et al. (2015)). As a result, children's mathematical thinking needs to be supported by teaching strategies that are compatible with their sensory attributes in kindergarten. Somasundaram, P. (2021)) draws attention to the use of a variety of instructional medium, sensory activities in the environment, and diversity in knowledge acquisition to enhance the educational process and make learning about the experiences that go along with it more fun and engaging. (Stephens and associates, 2015; Billion and Huth, 2023).From the foregoing, the authors can highlight the need for reevaluating mathematics curricula and courses for kids in Egypt and Kuwait. These curricula and courses should incorporate algebraic experiences and concepts in a way that aligns with the new ideas of experiences derived from the information age. Additionally, learning should be supported by teaching methods that are suitable for kindergarten students' abilities and readiness, allowing them to learn algebraic standards and principles.

REFERENCES

Adamuz-Povedano, N., Fernández-Ahumada, E., Teresa García-Pérez, M., & Montejo-Gámez, J. (2021). Developing number sense: An approach to initiate algebraic thinking in primary education. *Mathematics, 9(*5),13.

Arnawa, M., Ginting B.& Nita, S. (2021). Does The Use of APOS Theory Promote Students' Achievement in Elementary Linear Algebra? *International Journal of Instruction, 14(*3), 177.

Baeker, A., & Lamon, L. (2002): Algebraic and Arithmetic Structures, A Concrete Approach for Early Childhood Teachers. *Journal for Research in Mathematics Education, 20*(2), 93-109.

Belt, S. (1998): A Mathematics Activity Curriculum for Early Childhood and Special Education. *Journal for Research in Mathematics Education, 24*(1), 121-132.

Billion, L. (2021). Reconstruction of the interpretation of geometric diagrams of primary school children based on actions on various materials – A semiotic perspective on actions. *International Electronic Journal of Mathematics Education, 16*(3). https://doi.org/10.29333/iejme/11068.

Billion, L & Huth, M. (2023). *Mathematics in Actions and Gestures – A Young Learner's Diagrammatic Reasoning. Open Access.* https://link.springer.com/chapter/10.1007/978-3-031-37663-4_16#Sec2

Burker, M., & Curcio, R. (2000). *Learning Mathematics for a New Century*, Reston, Va: NCTM, ED, 528877.

Carpenter, T.L., & Carey, D. (1999): Models of Problem Solving: A Study of Kindergarten Children's Algebra Processes. *Journal for Research in Mathematics Education, 24*(5), 427-440.

Carpenter, T.M. (2003). *Thinking Mathematically Integrating Arithmetic and Algebra in Elementary School*. Portsmouth, New Hampshire: Heinemann, 89.

Chapman, (1999). *Algebra for Pre-School Through Problem Solving Strategy*. Internet Site: www.medyliz.com/2000.

Chimoni, M., & Pitta-Pantazi, D. (2017). Parsing the notion of algebraic thinking within a cognitive perspective. *Educational Psychology, 37*(10), 1189. https://doi.org/10.1080/01443410.2017.1347252.

Chui, H., Chin, H., Wan, B. (2024). Exploring the Effectiveness of Kindergarten Students' Online Learning. *International Journal of Instruction, 17*(3), 224.

During the COVID-19 Pandemic

Cumali Oksuz(2007). Children's Understanding of Equality and the Equal Symbol *International Journal for Mathematics Teaching and Learning*, (28), 1-20.

DOZ, D Cotič, M., Cotič, N. (2024). Development of Mathematical Concepts through a Problem-based Approach in Grade 3 Primary School. *Pupils*, *17*(3), 5.

David, A. (2000). *Early Algebra, Early Arithmetic: Treating Operations as Functions, Paper Presented at the 22nd Conference of the Psychology of Mathematics Education,* North American Chapter, Tucson, Arizona, 205-216.

Deborah, S., Russell, S., Bastable, V. (2009). Early Algebra to Reach the Range of Learners. *Teaching children mathematics, 16*(4), 230-237.

Een Yayah, E., Yanzi, H.& Drupadi, R. (2021). The Effect of the Scientific Approach-Based Learning on Problem Solving Skills in Early Childhood: Preliminary Study. *International Journal of Instruction, 14*(2), 292-293.

Elfiky, D. 2022. The Effect of a Whole Brain Teaching Based Instruction on Developing Number Competencies and Arithmetic Fluency in Kidergarten children. *International Journal of Instruction, 15*(1), 675.

Eriksson, H., & Eriksson, I. (2021). Learning actions indicating algebraic thinking in multilingual classrooms. *Educational Studies in Mathematics, 106*(3), 370. https://doi.org/10.1007/s10649-020-10007-y

Heaton, R. (1999): What is a Pattern? An Elementary Teacher's Early Efforts to Teach Math for Understanding, *Math in School, 19*(4), 202.

Iskander S. et al. (2021) A Systematic Review on Algebraic Thinking in Education. *EURASIA Journal of Mathematics, Science and Technology Education, 2022, 18*(1), em2065 https://typeset.io/pdf/a-systematic-review-on-algebraic-thinking-in-education-3192ltbf.pdf,1-15.

Karina & Doug. (2015). *Pathways to Professional Growth: Investigating Upper Primary School Teachers' Perspectives on Learning to Teach Algebra.* Online. https://ro.ecu.edu.au/ajte/vol40/iss4/6.

Komariah, A. Wiyono, Rusdinal,B. Abdullah, Z. & Kurniady, D. (2023). The Effect of a Training Program in Improving Academic Achievement in Mathematics. *International Journal of Instruction, 16(*3), 172-173.

Kulm & Others (2000). *Rating Algebra Textbooks, Paper Presented at the Annual Meeting of National Council of Teachers of Mathematics*, Chicago, U.S.A., ED.445538.

Moses, B. (1997): Algebra for a New Century. *Teaching Children Mathematics, 3*, 264-265.

NCTM (2000). *Principles and Standards for School Mathematics Reston*, Va: Ed. 3694632.

Nicole & Catherine. (2018). The Development and Initial Validation of an Assessment of Algebraic Thinking for Students in the Elementary Grades. *Educational Assessment, 23*(1), 1-17. DOI:10.1080/10627197.2018.1483191

Nina, A, Riska, S, Agus, A& Ali, M. (2021). Dominant Factors that Cause Students' Difficulties in Learning Abstract Algebra: A Case Study at a University in Indonesia. *International Journal of Instruction, 14*(1), 849

Leeming, F.C., et al. (1999): Effects of Participation in Class Activities on Children's Mathematical Skills. *D.A.L., 35*(10), P.6573.

Maldonads, S. (1999): Puzzles: Apathetically Neglected, Commonly Available Resource. *Young Children, 51*(4), 4-10.

Purpura, D. J., Hume, L. E., Sims, D. M., & Lonigan, C. J. (2011). Early literacy and early numeracy: The value of including early literacy skills in the prediction of numeracy development. *Journal of Experimental Child Psychology, 110*(4), 647–658. https://doi.org/10.1016/j.jecp.2011.07.004

Purpura, D. J., & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. Early Childhood Research Quarterly, 36, 259–268. https://doi.org/10.1016/j.ecresq.2015.12.020

Puter, S. (1998): Teaching and Learning Math for Young Children. *Educational Technology, 34(*4).

Umbara, U.; Munir, Rudi Susilana, EFW Puadi, (2021). Algebra Dominoes Game: Re-Designing Mathematics Learning During the Covid-19 Pandemic. *International Journal of Instruction, 14*(4), 48.

Usiskin, M. (1999). *Doing Algebra in grade K-4, In Algebra Thinking edited by Boses* Reston, Va: NCTM, Ed. 436820.

Radford, L. (2014). The progressive development of early embodied algebraic thinking. *Mathematics Education Research Journal, 26*(2), 262.

Radford, L., & Sabena, C. (2015). The question of method in a Vygotskian semiotic approach. In *Approaches to qualitative research in mathematics education* (Issue January 2014, (pp. 157-182). https://doi.org/ 10.1007/978-94-017-9181-6_7

Ralston, N. C., Li, M., & Taylor, C. (2018). The development and initial validation of an assessment of algebraic thinking for students in elementary grades. *Educational Assessment*, *23*(3), 211-227. https://doi.org/10.1080/10627197.2018.1483191.

Reikerås, E. (2023). Toddlers' Mathematics and Language – Two Sides of the Same Coin? First Online: 28 September 2023. https://www.researchgate.net/publication/374258591_Toddlers'_Mathematics_and_Language_-_Two_Sides_of_the_Same_Coin, 197.

Russell, S. J., Schifter, D., & Bastable, V. (2006). Is it 2 more or less? Algebra in the elementary classroom. *Connect, 19*(3), 1–3. http://www.terc.edu/newsroom/776.html

Saemz, L. (1999). Third Graders Interpretations of Equality and the Equal Symbol. *Education Studies in Mathematics, 35*, 153-187.

Sarah, P. (2014). Does Early Algebraic Reasoning Differ as a Function of Students' Difficulty with Calculations versus Word Problems? *Learn Disable Res PR act*; 29(3), 106–116.

Schliemann, A. D., Carraher, D. W., & Brizuela, B. M. (2013). *Bringing out the algebraic character of arithmetic: From children's ideas to classroom practice*. Taylor & Francis Group. https://doi.org/ 10.4324/9780203827192.

Stephens, A., Blanton, M., Knuth, E., Isler, I., & Gardiner, A. M. (2015). Just say yes to early algebra! *Teaching Children Mathematics*, *22*(2), 92. https://doi.org/ 10.5951/teacchilmath.22.2.0092

Somasundaram, P. (2021). The role of cognitive factors in year five pupils' algebraic thinking: A structural equation modelling analysis. *Eurasia Journal of Mathematics, Science and Technology Education, 17*(1), 1-12. https://doi.org/10.29333/ejmste/9612 **.**

Susan, Jo Russell., Deborah, Schifter., Virginia, Bastable. (2011). Developing Algebraic Thinking in the Context of Arithmetic. 43-69.

Tami, L. & Others (2001): The Mathematics Textbook: How Can it Serve the NCTM's Standards? *Arithmetic Teachers, 41*(6), 330-332, Feb.

Warren, E. (2004). *Generalizing Arithmetic: Supporting the Process in the Early Years.* in Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, (4), 339-455.

Wawan, R. (2022). Empirical Study of Factors Affecting the Students' Mathematics Learning Achievement. *International Journal of Instruction, 15*(2), 418.

Widya, K, Darhim, Tatang, H. & Turmudi. (2022). Improving AlgebraicL Thinking Ability Using Multiple Representation Strategy on Realistic Mathematics Eeducation. *Journal on Mathematics Education. 9*(2), 281-290.