Effect of Teaching with ECE Kit on Development of Mathematical Concepts in Early Years

Muhammad Ramzan
M.Phil Scholar Allama Iqbal Open University, Islamabad, Pakistan
Email: ramzan566@gmail.com
Dr. Rahmat Ullah Bhatti
Assistant Professor, Department of Early Childhood Education & Elementary Teacher Education,
Allama Iqbal Open University, Islamabad, Pakistan
Email: rehmat.ullah@aiou.edu.pk
Muhammad Waseem
PhD Scholar Allama Iqbal Open University, Islamabad, Pakistan
Email: dtewaseem@gmail.com

Abstract
This study investigates the impact of integrating an Early Childhood Education (ECE) Kit into mathematics instruction on the development of mathematical concepts in early year's education. The primary objective was to assess whether the utilization of age-appropriate teaching materials, interactive activities, and pedagogical strategies included in the ECE Kit results in significant improvements in the understanding and proficiency of foundational mathematical concepts among young learners. The study focuses on children aged 3 to 6, commonly referred to as the "early years," within preschool, pre-kindergarten, and kindergarten settings. To measure the effect, a comparative approach was employed, with one group receiving instruction using the ECE Kit and another group undergoing traditional mathematics instruction without the kit. Assessment tools included post-instructional evaluations, encompassing standardized mathematics tests, teacher observations, and performance on math-related tasks. Data analysis involves statistical methods to determine any statistically significant differences in mathematical concept development between the two groups. The findings of this research aim to provide valuable insights into the effectiveness of the ECE Kit as a pedagogical resource for early mathematics education. Ultimately, this study contributes to the ongoing discourse on enhancing mathematics instruction during the formative early years, potentially influencing teaching practices and educational policies to optimize mathematical learning experiences for young children.
Keywords: Early Childhood Education, (ECE) Kit, Mathematical Concepts, Development, Young Learners, Pedagogical Strategies

INTRODUCTION:

Children's innate curiosity and hands-on exploration shape their understanding of the world around them (Ackermann, 2001). Early Childhood Education (ECE) emphasizes the development of mathematical concepts through active engagement, critical thinking, and problem-solving rather than rote memorization (Bose &Seetso, 2016). From a young age, children exhibit a natural eagerness to learn (Hogan & Gomm, 2001). According to research, youngsters do not have enough exposure to Math-related activities at home or at school (Son & Hur, 2020) They are receptive to new mathematical ideas and encouraged to think scientifically, laying a crucial foundation for future learning. Early childhood, particularly the preschool years, serves as a formative period for mathematical development, with children naturally incorporating math into their play and interactions (Graham, Nash, & Paul, 1997).

Research spanning decades underscores the importance of early mathematical experiences in shaping children's cognitive development (Spelke, 2000). Strong foundational knowledge in mathematics significantly influences children's success in formal education (Griffin, 2005). However, the quality of early math experiences varies, with socioeconomic factors often influencing access to enriching opportunities (Raudenbush, 2009).

Recognizing the significance of early math education, educators aim to provide engaging and meaningful learning experiences. Yet, resources alone are insufficient without intentional teaching practices (Denee, R., & Cherrington, S. 2023). Mathematics should be integrated into everyday activities, fostering curiosity and problem-solving skills (Mak, Keung, & Cheung, 2018). In conclusion, effective early childhood education requires collaboration among educators, families, policymakers, and communities (Turja, Endepohls-Ulpe, & Chatoney, 2009). By prioritizing mathematical learning and leveraging innovative tools like the ECE Kit, we can cultivate a positive attitude toward mathematics and ensure equitable access to high-quality educational experiences for all young children.

LITERATURE REVIEW

1. **Importance of Early Childhood Education (ECE):** Children's innate curiosity and active exploration of their environment are highlighted as foundational elements of their cognitive development, particularly in mathematics. The literature emphasizes the shift away from rote memorization towards hands-on experiences and inquiry-based learning. Ackermann (2001) and Bose &Seetso (2016) advocate for ECE methodologies that encourage children to construct their own mathematical concepts, think critically, and engage in problem-solving.
2. **Global Initiatives and Importance of Mathematics:** The literature review acknowledges the significant role of global initiatives in promoting accessibility to quality ECE. UNICEF reports emphasize the transformative impact of early childhood education in mitigating the

effects of poverty and fostering a lifelong love for learning. Studies by Bailey et al. (2017), Jenkins & Duncan (2017), and others provide evidence of the long-term benefits of quality ECE in enhancing academic success and life outcomes.

3. **Mathematical Concepts and Language:** The universal nature of mathematical language is discussed, drawing from constructivist theories and cross-cultural studies. Bryant (1888) and Ganter & Wille (2012) argue that mathematics serves as a universal language, transcending national boundaries. They highlight the role of mathematical language in understanding patterns and gaining insights into the world, emphasizing its importance in early childhood education.
4. **Early Mathematical Skills:** Research by Clements & Sarama (2007), Sarama & Clements (2009), and Starkey et al. (2004) reveals that young children exhibit substantial mathematical knowledge before formal schooling. They demonstrate proficiency in counting, comparing quantities, and solving basic arithmetic problems. These early mathematical skills serve as the foundation for future academic achievements and are predictive of long-term success.
5. **Curriculum and Teaching Approaches:**
   The literature emphasizes the importance of integrating mathematics into ECE curriculum and adopting effective teaching methods. Baroody et al. (2006) advocate for guided discovery learning, where educators facilitate children's exploration and problem-solving. They stress the need for a comprehensive curriculum that prioritizes foundational mathematical concepts and aligns with children's cognitive development.
6. **Socioeconomic Factors:** Discussions on the impact of socioeconomic status on mathematical achievement highlight the disparities in access to quality ECE. Barnett & Belfield (2006) and Raudenbush (2009) argue that children from low-income backgrounds often face barriers to accessing quality early childhood education, leading to long-term academic disparities. Addressing these disparities is crucial for promoting equitable opportunities for all children.
7. **Teacher Training and Professional Development:** The literature emphasizes the importance of comprehensive teacher education programs in preparing educators to support young children's mathematical development effectively. NAEYC guidelines outline the essential components of teacher training, including theoretical understanding, practical competencies, and hands-on experience with young children. Todd Brown (2005) emphasizes the role of teachers' beliefs and self-efficacy in shaping instructional practices and student outcomes.
8. **ECE Kit provided by PHCIP:** Introducing the Human Capital Investment Project and its efforts to empower communities through

education and skill-building initiatives. The PHCIP aims to provide resources, training programs, and support to communities, fostering growth and development among individuals. By investing in early childhood education, the PHCIP seeks to build a brighter future for all members of society, promoting lifelong learning and success.

Objectives of Study

The objectives of this research are

1. To find out the effects of ECE kit on the development of mathematical concepts at ECE level.
2. To explore teaching methods using ECE kit for the development of mathematical concepts at ECE level.

Research Questions of the study

1 What were the effects of ECE kit on development of mathematical concepts at ECE level?

2 What type of teaching methods using ECE kit was being used for the development of mathematical concepts?

Hypotheses

The hypotheses of this study were as follows:

i. The ECE kit did not have a statistically significant impact on the development of scientific concepts at the ECE level.

ii. The ECE kit did not have a statistically significant impact on the development of mathematical concepts at the ECE level.

METHODOLOGY

It is experimental research. Experimental research seeks to find relationships between independent and dependent variables after a well-planned activity. This study was based on a posttest two-group design to evaluate the effect of teaching with the ECE kit on the development of mathematical concepts of Grade pre-1 students. The ECE kit was the independent variable, and mathematical concepts were the dependent variable. Self-developed lesson plans were administered to students as an experiment. Furthermore, an observation sheet was used as a data collection tool. Reliability and validity of research instruments were also determined. Before conducting the experiment, proper permissions were obtained from the respondents, and the purpose of the study was communicated to the respondents. Confidentiality of the responses was also assured to them.

Population of Study

The population of the study was consisted of all students (3 to 6 years) enrolled in ECE classes in public schools of Tehsil Minchinabad district Bahawalnagar.

Sample of Study

Using a random sampling technique, 44 students from the ECE class of one school (GES Ratteka) were selected as the sample for the study.

Instrumentation

The researcher developed research instruments (Lesson plans and Observation Sheet) with the help of the literature, supervisor, and experts.

Lesson Plans

The researcher personally prepared lesson plans to enhance mathematical concepts. These mathematical concepts were extracted from Chapter No. 2 of the Single National Curriculum for Early Childhood Care and Education, Grade Pre-I, in 2020. To facilitate better comprehension, all lesson plans were translated into Urdu.

Observation sheet

The Observation Sheet comprised a 5-point rating scale, consisting of twenty variables that included concepts such as Counting, Subtraction, Addition, Zero, Shapes, Colors, Time, Quantity of numbers, Capacity of objects, Comparison of objects by weight, Similarity and difference, Patterns, Hot and cold, Ascending and descending, Long and short, Directions, Calendar, Days of the week, Currency, and Small and big (see Annexure A).

Experimentation

The Government Elementary School Ratteka was selected as the research sample using a randomization method. To begin, the researcher obtained permission from the Deputy District Education Officer (M-EE) Minchinabad and the District Education Officer (M-EE) Bahawalnagar. Subsequently, the researcher visited the school and obtained permission from the school's Head Teacher.

Data Analysis and Interpretation

The data collected from the post-test was analyzed using SPSS. Descriptive statistics, including measures such as the mean and standard deviation, were employed to summarize the data. The results of the post-test were compared using a T-test to assess the effectiveness of the ECE kit in enhancing students' mathematical concept development, mean and standard deviation, were employed to summarize the data. The results of the post-test were compared using a T-test to assess the effectiveness of the ECE kit in enhancing students' mathematical concept development.

Results and Discussion

Table 1

Differences in the Development of Mathematical Concepts Using ECE Kit in Post-Observation Overall

Factor	Groups	N	Mean	Std. Deviation	T value	df	Sig
Mathematical Concept Development (Using ECE Kit)	Experimental Group	22	4.47	0.10	36.12	42	0.000
	Control Group	22	2.65	0.21			

Table 1 shows a big difference in math concept improvement after the intervention. The experimental group scored much higher (M=4.47, SD=0.10) compared to the control group (M=2.65, SD=0.21), and this gap

is statistically significant (t(42)=36.12, p<0.05). It's evident that the group using the ECE Kit has significantly better math development.

Table 2

Difference in Development of Mathematical concept Counting Using ECE Kit in Post observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
Counting	Experimental Group	22	4.51	0.24	19.95	42	0.000
	Control Group	22	2.44	0.43			

Table 2 shows a clear difference in counting skills improvement post-observation. The experimental group scored higher (M=4.51, SD=0.24) compared to the control group (M=2.44, SD=0.43), and this gap is statistically significant (t(42)=19.95, p<0.05). It's evident that using the ECE Kit leads to better counting skills in pre-primary education.

Table 3

Difference in Development of Mathematical concepts Subtraction Using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
Subtraction	Experimental Group	22	4.33	0.32	15.49	42	0.000
	Control Group	22	2.61	0.41			

Table 3 highlights a significant difference in subtraction skills improvement post-observation. The experimental group scored higher (M=4.33, SD=0.32) compared to the control group (M=2.61, SD=0.41), and this gap is statistically significant (t(42)=15.49, p<0.05). It's clear that using the ECE Kit leads to better subtraction skills in early education.

Table 4

Difference in Development of Mathematical concepts Addition Using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
Addition	Experimental Group	22	4.52	0.27	14.89	42	0.000
	Control Group	22	2.81	0.46			

Table 4.4 displays a significant difference in addition skills improvement post-observation. The experimental group scored higher (M=4.52, SD=0.27) compared to the control group (M=2.81, SD=0.46), and this difference is

statistically significant (t(42)=14.89, p<0.05). It's evident that using the ECE Kit leads to better addition skills in early education.

Table 5

Difference in Development of Mathematical concept of ZERO using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
ZERO	Experimental Group	22	4.48	0.24	16.99	42	0.000
	Control Group	22	2.65	0.44			

Table 4.5 highlights a significant difference in zero-related math concept improvement post-observation. The experimental group scored higher (M=4.48, SD=0.24) compared to the control group (M=2.65, SD=0.44), and this gap is statistically significant (t(42)=16.99, p<0.05).Clearly, using the ECE Kit leads to better understanding of zero concepts in early education.

Table 6

Difference in Development of Mathematical concept SHAPES Using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
SHAPES	Experimental Group	22	4.57	0.28	17.30	42	0.000
	Control Group	22	2.59	0.45			

Table 6 shows a significant difference in shape-related math concept development post-observation. The experimental group scored higher (M=4.57, SD=0.28) compared to the control group (M=2.59, SD=0.45), and this gap is statistically significant (t(42)=17.30, p<0.05). It's clear that using the ECE Kit leads to better understanding of shapes in early education.

Table 7

Difference in Development of Mathematical concepts COLOURS Using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
COLOURS	Experimental Group	22	4.39	0.29	19.28	42	0.000
	Control Group	22	2.72	0.29			

Table 7 highlights a significant difference in color-related math concept development post-observation. The experimental group scored higher (M=4.39, SD=0.29) compared to the control group (M=2.72, SD=0.29), and

this difference is statistically significant (t(42)=19.28, p<0.05).Clearly, using the ECE Kit leads to better understanding of colors in early education.

Table 8

Difference in Development of Mathematical concept Time using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	Df	Sig
Time	Experimental Group	22	4.45	0.40	14.34	42	0.000
	Control Group	22	2.75	0.39			

Table 8 shows a significant difference in time-related math concept development post-observation. The experimental group scored higher (M=4.45, SD=0.40) compared to the control group (M=2.75, SD=0.39), and this difference is statistically significant (t(42)=14.34, p<0.05). It's evident that using the ECE Kit leads to better understanding of time concepts in early education.

Table 9

Difference in Development of Mathematical concepts QUANTITY OF NUMBERS using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
QUANTITY OF NUMBERS	Experimental Group	22	4.49	0.27	17.14	42	0.000
	Control Group	22	2.54	0.46			

Table 9 highlights a significant difference in quantity-related math concept development post-observation. The experimental group scored higher (M=4.49, SD=0.27) compared to the control group (M=2.54, SD=0.46), and this difference is statistically significant (t(42)=17.14, p<0.05).Clearly, using the ECE Kit leads to better understanding of number quantity in early education.

Table 10

Difference in Development of Mathematical concepts CAPACITY OF OBJECTS using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
CAPACITY OF OBJECTS	Experimental Group	22	4.48	0.27	14.82	42	0.000
	Control Group	22	2.66	0.51			

Table 10 shows a significant difference in object capacity-related math concept development post-observation. The experimental group scored higher (M=4.48, SD=0.27) compared to the control group (M=2.66,

SD=0.51), and this difference is statistically significant (t(42)=14.82, p<0.05). It's evident that using the ECE Kit leads to better understanding of object capacity in early education.

Table 11

Difference in Development of Mathematical concept COMPARISON OF OBJECTS BY WEIGHT using ECE Kit in Post- observation

Concept	Groups	N	Mean	Std. Deviation	T value	df	Sig
COMPARISON OF OBJECTS BY WEIGHT	Experimental Group	22	4.46	0.36	13.12	42	0.000
	Control Group	22	2.52	0.59			

Table 11 shows a significant difference in object weight comparison-related math concept development post-observation. The experimental group scored higher (M=4.46, SD=0.36) compared to the control group (M=2.52, SD=0.59), and this difference is statistically significant (t(42)=13.12, p<0.05). Clearly, using the ECE Kit leads to better understanding of object weight comparison in early education.

FINDINGS

1. The study found that using the ECE Kit boosts kids' math skills. It's because the kit has fun activities that make learning math enjoyable. Teachers also use helpful methods like guiding exploration, which helps kids understand math better.
2. Using the ECE Kit helps kids learn counting better. They played counting games and used hands-on materials, which made learning fun. Teachers also showed them how to count clearly, which helped them learn better.
3. The study checked if the ECE Kit helps kids understand subtraction. It did - the group using the kit improved a lot. Activities like subtraction puzzles and real-life problems, plus hands-on learning, made it easier. Teachers also used personalized teaching and group work, which helped kids learn better.
4. The study found that using the ECE Kit helps kids learn addition better. Activities like games and hands-on learning make it fun, while teachers give feedback to help kids master addition skills.
5. The study found that the ECE Kit helps kids understand zero in math better. Activities like zero puzzles and exploring number lines made learning meaningful. Teachers also used strategies like reflecting on thinking and concept mapping to help kids grasp zero.
6. The study found that the ECE Kit helps kids recognize shapes better in math. Activities like sorting games and exploring shapes made learning

hands-on. Teachers used strategies like inquiry-based learning to help kids understand spatial reasoning and geometry.

7. The study found that the ECE Kit helps kids understand colors in math. Activities like mixing colors and creating patterns engaged students in learning. Teachers used visual aids to connect colors with math concepts.
8. The study found that the ECE Kit helps kids understand time in math. Activities like time-telling games and exploring calendars engaged students in learning. Teachers used strategies like mnemonic devices to help students grasp time concepts.
9. The study found that the ECE Kit helps kids understand quantity in math. Activities like estimation games and measuring engaged students in hands-on learning. Teachers used strategies like using manipulative to connect numbers with real-world quantities.
10. The study found that the ECE Kit helps kids understand object capacity. Activities like comparing volumes and filling containers engaged students in learning. Teachers used hands-on exploration to help students grasp object capacity.
11. The study found that the ECE Kit helps kids understand object weight. Activities like weighing experiments engaged students in hands-on learning. Teachers used guided discovery to help students understand weight principles.

DISCUSSION

In this study, researcher investigated the impact of using an Early Childhood Education (ECE) Kit on the development of mathematical concepts in young children. The study compared an experimental group that used the ECE Kit to a control group. The results indicated that the experimental group, which utilized the ECE Kit, showed significant improvements in various mathematical concepts compared to the control group.

The study's findings supported the existing literature emphasizing the importance of early childhood education in shaping mathematical understanding, with references to Raudenbush (2009). The study also utilized a constructivist approach, consistent with contemporary pedagogical practices in ECE, as supported by Bose and Seetso (2016). This approach encouraged active construction of mathematical knowledge among children, facilitated by the hands-on materials of the ECE Kit.

Specifically, the experimental group demonstrated superior performance in areas such as counting, subtraction, addition, understanding of zero, shapes, colors, time, and more. These findings align with research highlighting the long-term impact of early mathematics experiences on a child's success in schooling, as indicated by Boaler (2014).

Furthermore, the study acknowledged the importance of play in early mathematics, consistent with literature by Graham, Nash, & Paul (1997).

Play was found to naturally introduce and reinforce mathematical concepts, making learning enjoyable and engaging for young children.

Conclusions

Based on the extensive analysis conducted in this thesis, it is evident that the incorporation of Early Childhood Education (ECE) Kits into teaching methodologies has a profound impact on the development of mathematical concepts at the ECE level. Through a comprehensive examination of various factors, including the influence of ECE Kits on counting, subtraction, addition, zero, shapes, colors, time, quantity, object capacity, comparison, patterns, temperature, order, measurement, directions, calendar, days of the week, currency, and size-related mathematical concepts, compelling evidence has emerged supporting the efficacy of ECE Kits in promoting mathematical understanding among young learners.

The findings consistently demonstrate that interactive activities facilitated by ECE Kits play a pivotal role in engaging students in hands-on learning experiences, thereby fostering deeper comprehension and retention of mathematical concepts. Moreover, pedagogical strategies such as guided exploration, scaffolded instruction, modeling, explicit instruction, differentiated instruction, peer collaboration, formative assessment, feedback loops, meta-cognitive reflection, concept mapping, inquiry-based learning, concept extension activities, multisensory instruction, visual aids, mnemonic devices, real-world application tasks, manipulative-based instruction, problem-solving tasks, guided inquiry, guided discovery, graphic organizers, pattern extension challenges, cooperative learning, directional games, positional language exercises, repeated practice, contextual learning, financial literacy instruction, and direct comparison have been instrumental in supporting student learning and skill development across various mathematical domains.

These findings underscore the significance of integrating ECE Kits into early childhood education programs to enhance mathematical learning outcomes for preschool-aged children. By leveraging the interactive activities and pedagogical strategies discussed in this thesis, educators can create dynamic and engaging learning environments that facilitate the development of mathematical concepts in young learners. This research contributes valuable insights to the field of early childhood education and informs educators and policymakers about effective approaches to fostering mathematical understanding in early years education. Ultimately, the implementation of ECE Kits holds great promise for enriching early childhood education programs and empowering young children to succeed in mathematics and beyond.

Recommendations

1. **Continued Implementation of ECE Kit**: The study underscores the significant impact of the ECE Kit on mathematical concept development in early childhood education. Therefore, it's

recommended to continue implementing the ECE Kit, as it has proven effective in enhancing mathematical understanding among pre-primary students.

2. **Refinement of Teaching Methods**: Teaching methods utilizing the ECE Kit have shown promise in fostering mathematical development. It's advisable to further explore and refine these methods to maximize their effectiveness in promoting mathematical understanding among young learners.
3. **Focus on Counting Skills**: Given the notable improvement in counting skills among the experimental group, emphasis should be placed on utilizing the ECE Kit to strengthen counting skills among pre-primary students.
4. **Integration into Addition and Subtraction Lessons**: Incorporating the ECE Kit into the curriculum for teaching addition and subtraction is recommended, considering the significant improvement observed in these areas among students using the kit.
5. **Holistic Integration of ECE Kit**: The positive impact of the ECE Kit extends beyond counting to various other mathematical concepts like shapes, colors, and time. Integrating the kit into teaching these concepts can facilitate holistic mathematical development among pre-primary students.

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