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Redefining Early Literacy: A STEAM Approach at AZ Zahra NU Kindergarten, Magelang

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Abstract
This research investigates the implementation of a Science, Technology, Engineering, Arts, and Mathematics (STEAM)-based learning approach at AZ Zahra NU Salaman Magelang Kindergarten, aiming to enhance early childhood literacy in reading, writing, and arithmetic. Employing a qualitative, descriptive case study methodology, the study focuses on learning design, execution, and evaluation through the STEAM lens. Data were collected via observations, interviews, and documentation involving the principal, deputy principal, and classroom teachers. The learning process at Az-Zahra NU Kindergarten has transitioned from conventional drills to a STEAM approach, utilizing loose-part media and play activities tailored to each child's unique learning style. The study reveals a significant paradigm shift in early childhood education from traditional methods to a more dynamic, integrative STEAM approach. This shift promotes holistic development and simplifies educational planning, enabling educators to concentrate on adaptive, child-centric strategies. The findings highlight the successful integration of STEAM elements into the curriculum, enhancing children's engagement and creativity in learning. However, the research's limitation lies in its focus on a single institution and qualitative data, suggesting the need for broader, mixed-method studies in diverse educational settings. Future research should also include longitudinal studies to assess the long-term impacts of the STEAM approach. In conclusion, the study presents a compelling case for the widespread adoption of STEAM in early childhood education, offering a more effective and engaging method for fostering early literacy and comprehensive child development in the 21st century.

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Introduction

Literacy, a fundamental skill in human development and societal progress, is essential for individuals to thrive in a rapidly evolving world. Despite numerous advancements in educational methodologies, traditional drill-based approaches to literacy, encompassing reading, writing, and numeracy (listing), remain prevalent. However, these methods often neglect the holistic development of children, focusing narrowly on rote learning and memorization (Agustin & Latif, 2023; Johnston et al., 2022; Perignat & Katz-Buonincontro, 2019). The emergence of the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach has introduced a paradigm shift, emphasizing a more integrative and engaging method of learning (Bayles et al., 2021; Johnston et al., 2022; Thoma et al., 2023). This study aims to explore the efficacy and impact of the STEAM approach in enhancing literacy skills among early learners, a subject of growing importance in educational research and practice.

The misdirection in building literacy skills starts at the early childhood education level (Napitupulu, 2021). Starting from early childhood education, children taught literacy using drill methods experience negative consequences, such as stress, psychological disturbances, and disruptive behavior (Apriyanti & Aprianti, 2023). Literacy methods focusing solely on academic intelligence from an early age provide short-term benefits but pose long-term threats to children (Lipsey et al., 2018). This misconception continues to spread in society (Lestari & Puji ;

Pada, 2023), as evidenced by the increasing number of institutions offering courses and tutoring services to achieve literacy skills quickly.

TK Az-Zahra NU Salaman Magelang is one of the early childhood education institutions that has stimulated essential literacy aspects, particularly the contextual and meaningful development of early literacy in children, by implementing the independent curriculum in early childhood education. Contextual means children learn by utilizing objects from their immediate environment closely related to their daily lives. Meaningful means that children learn to read, write, and do arithmetic not just to be skilled without understanding and comprehension, as in drill methods, but also to comprehend what they hear and calculate. With the implementation of the independent curriculum in early childhood education, TK Az-Zahra NU Salaman Magelang has transitioned from primary essential racy stimulation using drill methods to contextual and meaningful learning.

Previous research indicates three main trends. First, studies that demonstrate the stimulation of early literacy development through picture cards (Hamdiah & Priyanti, 2023), word cards (Setyowati, 2023), crossword puzzles (Sitorus et al., 2023), and letter cards (Kristianisngsih et al., n.d.). Second, studies explore various early literacy methods using big books (Tatminingsih, 2022), busy books (Ompok et al., 2018), and smart boards (Ismawati et al., 2023). Third, studies extensively investigate early literacy methods using mobile applications, such as educational games for reading fluency (Rahmadani & Muryanti, 2023) and the Quiziz app to enhance literacy skills (Rosdiana et al., 2023). Thus far, no early literacy teaching method using the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach has been used. Studies on STEAM-based teaching approaches have mainly focused on fostering creativity and problem-solving in early childhood (Ananda et al., 2023; Karlina et al., 2023; Maarang et al., 2023; Najamuddin et al., 2022). There have been no studies focusing on the implementation of STEAM for early literacy stimulation.

This study aims to fill the gaps in previous studies discussing reading, writing, and arithmetic methods for early childhood in Indonesia. The discussion in this study focuses on models, approaches, and techniques for teaching reading, writing, and arithmetic (callistingith STEAM. The study shows that the STEAM method stimulates children to observe, group, compare, measure, predict, think critically, communicate, be creative, and collaborate. This study also demonstrates that with STEAM, basic literacy in children is stimulated according to their developmental stages. In line with these points, two research questions can be formulated. First, how do educators design lesson plans with the STEAM approach at TK Az-Zahra NU Salaman Magelang? Second, how can implementing the STEAM approach at TK Az-Zahra NU Salaman Magelang enhance the knowledge of early childhood basic literacy? Through this focus, the research hopes to produce a comprehensive study on implementing the M approach to improve early childhood reading and writing literacy (Calistung).

This study is based on the argument that the stimulation process for early childhood education at TK Az-Zahra NU Salaman Magelang occurs in a contextual and meaningful manner because it employs the STEAM method. The STEAM method not only encourages children to learn about language aspects, such as receptive and expressive language and pre-literacy skills, as well as cognitive aspects like problem-solving, critical thinking, creativity, and symbolism, but it also encompasses an engineering or design component. This represents the highest level of thinking or is found in the category of high-order thinking. STEAM helps children excel in reading, writing, and arithmetic and nurtures and facilitates their creativity, imagination, and fantasies, among the most valuable assets children possess. The STEAM approach also serves as a means to introduce a variety of media sourced from the surrounding environment.

Research on learning to read, write, and count without drill: A study on the implementation of STEAM-infused education at TK Az Zahra NU Salaman Magelang is both urgent and crucial. There are three main reasons why this study is essential. Firstly, the STEAM method offers comprehensive benefits, particularly in stimulating early childhood reading, writing, and counting. Secondly, the reading, writing, and counting methods have often been

misunderstood in their application in Indonesia, leading to the prohibition of early learning through drill-based methods. Despite this prohibition, early childhood educators still conduct extracurricular lessons, and the growth of supplementary reading, writing, and counting guidance is on the rise. Thirdly, STEAM can serve as an option for contextual and meaningful methods for learning to read, write, and mathematics.

Methods

The research method used is qualitative, and the research design is descriptive with an in-depth case study approach. The research findings present data on the implementation of steam-loaded learning in kindergarten, explicitly focusing on the stages of learning planning, learning implementation, and learning evaluation. What is meant by STEAM in this study is the process of educators stimulating the fields of science, Technology, Engineering, Art, and Mathematics. Data collection techniques used included observation, interviews, and documentation. Informants consisted of the Principal, Deputy Principal, and Classroom Teacher of Grade B. Observations were conducted on four educators and 45 children divided into four classes. Researchers validated data using source triangulation techniques. Researchers conducted a document study of lesson plans. Afterward, researchers analyzed the data interactively, building a dynamic and interconnected relationship between research instruments and data collected in the field.

The study focuses on lesson planning with STEAM methods, implementation of STEAM methods, and evaluation of learning with STEAM methods. These themes are then formulated into indicator points. The next stage is to build linkages and implications between findings in each aspect of STEAM aspects. Researchers used the concept of data analysis and the steps proposed by Miles and Huberman (Kalpokaite & Radivojevic, 2019). The diagram below provides a clearer picture of the interactive analysis model.

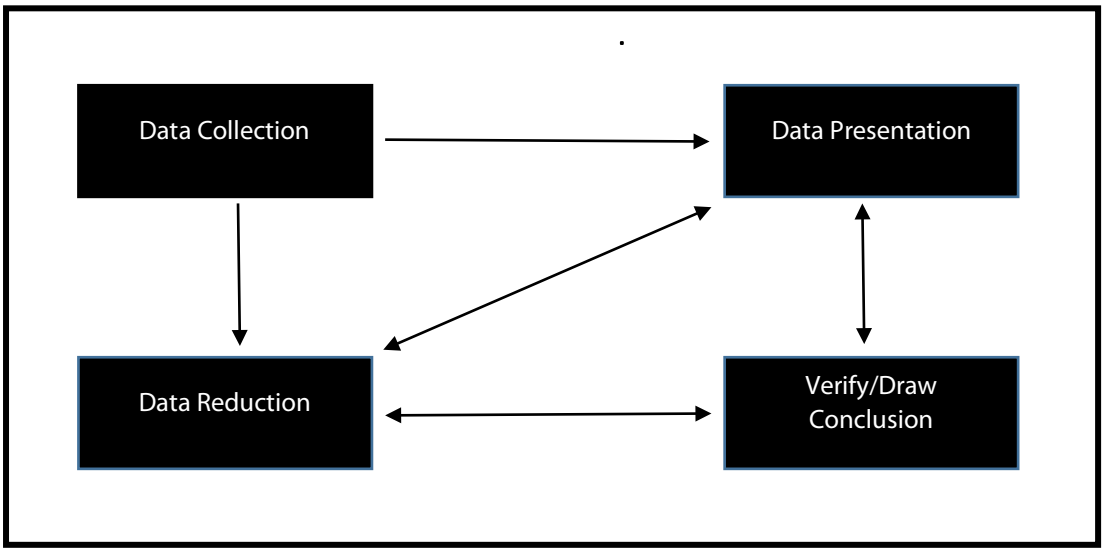

Figure 1. Model of Interactive Data Analysis by Miles and Huberman

Result

3.1. Learning Design with a STEAM Approach

Az-Zahra NU Salaman Magelang Kindergarten, located on Jalan Magelang-Purworejo KM. 17 Kauman Salaman Magelang, has a vision of healthy, cheerful, faithful, knowledgeable, and characteristic children. Az-Zahra NU Kindergarten was founded on July 1, 2009. The establishment of Az-Zahra NU Kindergarten began with the concerns of the elders and administrators of the Muslimat and Fatayat Nahdlatul Ulama Anak Salaman Branch seeing the condition of the NU Building, which stood majestically on the side of the road but looked unkempt because it was only occupied when there were selapanan recitations and other extensive recitation activities. Moreover, even then, it only uses the second floor of the building.

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Apart from that, the elders are also very concerned about the condition of children's education in Indonesia, where there is much violence against children and a lack of parental supervision over their children's interactions due to busy parents who work hard all day to earn a living for the family. Starting from there, the Salaman Branch NU Children's Muslimat Management had the idea to establish early childhood education, where the government was promoting PAUD at that time.

In order to maximize the science taught, innovative learning design principles must establish a new learning environment. Children's involvement can be increased with the aid of creative learning designs. Children can benefit from a more individualized approach based on their unique learning preferences and needs. The training plan of the Az-Zahra NU educator using a STEAM approach is diagrammed below, specifically:

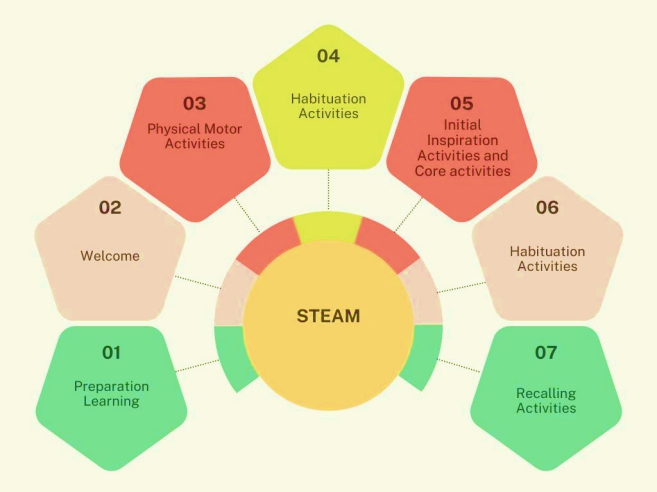

Figure 2. Learning Design with a STEAM Approach

Az-Zahra NU Kindergarten educators prepare activity plans once a week. Az-Zahra Kindergarten educators have used planning as teaching modules to implement the independent curriculum, valid for five days, namely Monday–Friday. Based on the results of interviews with educators, after the COVID-19 pandemic, Az-Zahra Kindergarten educators have slowly reduced learning using worksheets (LK) and switched to learning using loose-part media.

Az-Zahra NU Kindergarten has changed from learning listing with LK and is now switching to a learning process using a STEAM approach through loose part media. Az-Zahra NU Salaman Magelang Kindergarten, whose learning planning uses teaching modules for five days, means planning administration is lighter. In daily life, educators focus on preparing loose part materials to be organized into at least three play activities according to the subtopics in the teaching module. Activities with loose part media must at least have aspects of development activities to train children's imagination in designing things; some activities stimulate children's pre-literacy aspects, whether reading and writing using media made from loose part and counting activities using loose part material.

Az-Zahra NU's kindergarten educators arrived before 07.00 WIB. After that, they welcomed the arrival of the children while standing in the schoolyard. Every time a child comes, the educator stimulates him by saying greetings while encouraging the child to answer and shake hands. After that, the educator stimulates children to put their shoes and bags in their place. After that, the activity continued with physical motor activities, both outdoor and indoor. Educators start with habituation activities, which are the development of religious and moral values, starting with instilling the values of faith and worship and stimulating good behavior and morals.

Before entering the main activity, the educator carries out inspiration/play grounding activities in the first observation activity according to the topic and theme. At the first moment of observation, with the topic Objects, the subtopic used bottles. the educator carried out initial

inspiration by watching a video using a laptop with the title "Nussa Playing Kites". After watching the video, the educator brainstorms with the children about kites. Educators provoke exploratory questions, such as what are the names of kites, which kite is the smallest, how long is the kite and other exploratory questions.

The second observation activity, with the topic of the sky and subtopic, the moon, educators carry out inspirational activities by using a story book about the story of the prophet Muhammad who split the moon and watching videos about various celestial objects, starting from the sun, stars and also the moon. After that, the educator deepens the topic by brainstorming about the content of the stories and videos that have previously been watched. Children are equipped with knowledge about celestial bodies, especially the moon, starting from the benefits of the moon, the shape of the moon and when the moon can rise and set as well as the names of the months of the year. Educators invite children to visit pottery craftsmen directly.

In this third observation activity, with the topic of my environment, subtopic of pottery, educators invite children to visit pottery craftsmen with the aim of enabling children to understand the potential of the environment. At the pottery crafts place, children are first invited to see the land used to make pottery. The children also observed the pottery kiln and saw the process and practice of making pottery. After that, children learn to make pottery by shaping it according to their imagination and experience.

Table 1. Learning Design with a STEAM Approach

Time	Activity	STEAM Design
The day before	Preparation Learning	Educators design a minimum of three activities which contain development, numeracy and pre-literacy activities
07.00-07.30	Welcome	Getting used to shaking hands, putting shoes and bags in their place
7.30-08.00	Physical Motor Activities	Outdoor play activities, slides, swing board etc
08.00-08.45.	Habituation Activities	The habit of strengthening religious and moral values, memorizing prayers, short letters and worship practices
08.45-09.55.	Initial Inspiration Activities	Read a STEAM-filled storybook, go outside with the Scientific method
	Core activities	Carrying out play activities with loose part media
10.00-12.00	Habituation Activities	Yanbu'a recitation, noon prayers, lunch
12.00.12.30	Recalling Activities	Conversation and discussion activities provide space for children to talk about what they have done

3.2. Implementation of Learning with a STEAM Approach

3.1.1. Science

In the first observation, the educator was observed using physical science, specifically a kite, for the learning process. The educator stimulated the students to learn about the color, shape, texture, size, and movement of objects known as kites. In this activity, the children were encouraged to create kites with the inviting phrase "the beauty of our kites."

In the second observation, the educator was observed using Earth and Space Science, focusing on the moon as part of the learning process. The educator provided stimulation and explanations to help the children understand various celestial objects, such as the moon, stars, and the sun, as well as their effects, such as weather, the occurrence of day and night, seasonal changes, and temperature differences.

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Figure 3. Learning Tools for Science

Figure 4. Children Learning Earth science

3.1.2. Technology

When we think about technology, the immediate association is often with smartphones and computers. However, in technology, it also encompasses all types of objects created by humans. Simple tools such as scissors and inclined planes are also considered technology. These simple technologies enable children to understand how tools help us complete tasks.

Educators at TK Az-Zahra NU use a variety of technologies as needed. They facilitate the use of scissors to make kites, provide simple bamboo, branches, pebbles, popsicle sticks, and used bottle caps. To simulate how celestial objects rotate, educators use a globe and then use a flashlight as a representation of the moon. They stimulate children to comprehend the process of day and night changes and when the moon can illuminate the Earth.

3.1.3. Engineering

When children have already been inspired or provided with a foundation through stories or by watching videos, educators facilitate their learning using various media. As a result, the children engage in planning and engineering by using a variety of materials, which are then designed, processed, and constructed. This helps children understand how kites are made and why kites can fly.

When children use a globe as a replica of the Earth and a flashlight as a representation of the moon, educators stimulate them to learn about the processes behind the occurrence of day and night, and why it becomes dark and bright during the night. Educators also encourage children to learn about space-related processes. After finishing their designs, children are motivated to write their own names on their finished works.

Figure 5. writing the name of the kite

Figure 6. Children make celestial bodies

3.1.4. Arts

Art is sensory exploration. Children can feel the paint on their hands and see the colorful patterns adorning the paper. Children also incorporate symbols in their art that represent real objects, events, and emotions. Drawing provides an opportunity for children to express what they know and feel.

The image below illustrates a child expressing their ideas and emotions through free-form drawing, guided by imagination and knowledge. Educators encourage children to draw, learn about color combinations, and instill the habit of writing their names on every piece of artwork, including drawings, paintings, or collages made from red leaves.

Figure 7. flower collage of red shoots

Figure 8. Children draw according to their imagination

3.1.5. Math

Mathematics involves numbers and operations, measurements, patterns, geometry, and spatial abilities. Educators stimulate children's mathematical abilities by introducing numeric symbols and using these symbols at the beginning of activities, such as counting the number of children and identifying those who didn't attend school. Educators also instill the practice of writing the date, month, and year.

The photo below shows activities related to recognizing numeric symbols and counting pebbles according to the number of numeric symbols. In one of the images, children are encouraged by educators to write their birthdate, the month, and the year corresponding to their time of birth.

Figure 9. Counting the number of gravel

Figure 10. Writing date-year of birth

The table below illustrates the process of implementing STEAM-based learning at TK Az Zahra NU Salaman Magelang. In the initial inspiration phase, educators employ a variety of inspirational methods, including activities like reading storybooks using printed media, watching videos, storytelling with puppets, and even field trips to relevant locations based on the topic. This is followed by science-related activities, which can encompass physical science, life science, and space science. Educators also facilitate the use of various tools to help children assemble, arrange, create, and design projects related to the topic. For each design and

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project, educators provide reinforcement through provocation, including activities related to numeracy, writing, grouping, and classification concepts.

Table 2. Implementation of Learning with the STEAM Approach

Aspects STEAM	Activities
Playing ground	Stimulation through STEAM-laden stories, going outside with the Scientific method
Science	Encouragement for children to conduct experiments and observations in the fields of Physical Science, Life Science, and Earth and Space Science.
Technology	Facilitate educators in preparing all objects that can make it easier and help children in carrying out play activities
Engineering	Stimulation of educators to design, create and develop to produce products
Art	Educators stimulate children to engage in play activities that contain art, such as fine arts, dance, music and drama.
Mathematics	Educators stimulate children to become familiar with the concepts of numbers, comparisons and grouping/classification

Discussion

This study found that learning with a STEAM approach can stimulate children's language and cognitive learning aspects, especially in the areas of reading, writing, and numeracy. In addition to science, STEAM thinking is beneficial for other subjects (Milara et al., 2020). Educators do not use drill methods to accompany children in learning to read, write, and count, but indirectly, children's literacy skills are still stimulated through contextual and meaningful activities. The inability to learn, the need for a special education program, learning disabilities, special needs related to education, or behavioral issues at school are all considered academic difficulties (Benavides-Varela et al., 2020; Rimm-Kaufman et al., 2006). These activities include writing their own names on project work, writing their birthdate, month, and year, counting using pebbles, and classifying types of soil and rock formations. Children learn literacy through concrete objects, so they not only memorize but also understand and comprehend what they are doing (Bowcher & Zhang, 2020; Conica et al., 2023).

The STEAM approach at Az Zahra NU Kindergarten demonstrates a significant shift from conventional *calistung* learning methods, moving towards more engaging and interactive activities using loose-part media. This transition underlines a pedagogical change, focusing on nurturing children's imagination, pre-literacy, and numeracy skills in a more holistic manner. The results indicate a meaningful improvement in children's literacy skills, which were previously hindered by more rigid and less interactive teaching methods.

Learning with a STEAM approach is not only contextual and meaningful, but educators also stimulate adaptation according to the stages and development of children in language and cognitive development. In the expressive language aspect, before children can read, they must go through stages of fantasy, self-concept formation, picture reading, reading introduction, and fluent reading stages (Agustin & Latif, 2023). The stages of writing include children's scribbles, directed scribbles, repeated lines and letter shapes, and letter practice. All stimulation for language and cognitive aspects is based on considering the stages of child development, both in the context of providing materials and early activity stimulation, as well as support during activities.

Learning with a STEAM approach not only stimulates language and cognitive aspects but also engineering or designing and artistic aspects. All these aspects are integrated and blended within a series of activities. These integrated learning activities have the potential to greatly enhance students' creativity and learning content knowledge, design skills, innovation, and comprehension of connected computing concepts in formal, non-formal, and informal learning environments STEAM (Aguayo et al., 2023). A single activity may contain complex elements, for

instance, when a child creates and designs a kite, they learn fine motor skills through cutting, cognitive skills through differentiating and classifying kites, cause-and-effect concepts by understanding how kites work, and language skills by describing various types of kites.

Early academic education has a longer-term negative effect than play-based education. According to a Darling-Hammond study, the German government funded a large-scale study in the 1970s that compared graduates of 50 play-based kindergartens with graduates of 50 children's schools based on academic instruction over time (Bjorklund, 2022). Despite the initial academic advantages of direct instruction, by fourth grade children from direct instruction kindergartens performed significantly worse than those from play-based kindergartens on every measure used. In particular, they were less proficient in reading and math and less well adjusted socially and emotionally. At the time of the study, Germany was gradually shifting from traditional play-based kindergartens to academic kindergartens. At least partly as a result of the study, Germany reversed that trend; they returned to play-based kindergartens.

Similar studies in the United States have produced comparable results. In Rebecca Marcon's study that focused on mostly African-American children from poor families. As expected, she found-in her sample of 343 students-that those who attended preschools centered on academic training showed an early academic advantage over those who attended play-based preschools; but, by the end of fourth grade, this early advantage was reversed: Children from play-based preschools were now performing better, earning significantly higher school grades, than those from academic preschools, the study did not include assessments of social and emotional development (Longhine, 2022).

Children taught to read from kindergarten had a slight advantage but more long-term adverse effects. Early academic training somewhat improved children's immediate scores on the specific tests for which the training was intended (not surprisingly), but these early gains were lost within 1 to 3 years and, at least in some studies, eventually reversed (Peterson & Elam, 2020). Perhaps more tragic than the lack of long-term academic gains from early academic instruction is the evidence that such instruction can produce long-term losses, especially in the areas of social and emotional development.

This research differs from previous studies. In early 2011, STEAM, a different study, underwent a reformulation that framed it around four pillars: creativity, inclusion, citizenship, and new technologies (Quigley et al., 2020). While previous studies focused on literacy development using letter cards, books, and applications, this research employs a STEAM approach for the development of children's literacy, especially in reading, writing, and numeracy. With the STEAM method, educators stimulate literacy aspects using a variety of methods, techniques, and media. Educators may utilize letter cards, books, applications, as well as pebbles, sand, and natural materials that are contextually relevant to the institution's surroundings.

The main challenge in STEAM-based learning lies with educators and parents (Lestari & Puji ; Pada, 2023). Educators' competence to transition from traditional literacy teaching methods poses its own challenges. Educators require time and a process to make this shift, as they have been using drill-based methods for literacy learning for too long. Equally important challenges are faced by parents. Parents often worry and become anxious if their children have not yet developed literacy skills during their early education, leading many to enroll their children in tutoring centers.

Therefore, there is a need for a collaborative effort and reinforcement between educational institutions, particularly educators and parents, to establish a common understanding of the stages of reading, writing, and numeracy development. In order to solve problems as future citizens, students are taught to be innovative, creative, critical thinkers, collaborate well, communicate clearly, and absorb new information (Tabiin, 2020). This collaboration is crucial because, in the course of their child's education, many parents feel that literacy skills are not adequately emphasized in school, leading them to seek specialized literacy

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tutoring. In the end, it is the children who suffer. Educators and parents need to develop a shared perspective on literacy teaching methods.

The findings from Az Zahra NU Kindergarten's STEAM approach underscore the need for a paradigm shift in early childhood literacy education. It challenges educators and policymakers to rethink traditional methods and embrace more dynamic, integrated approaches. This study highlights the potential for STEAM-based learning to be adopted more widely, encouraging a holistic and engaging pedagogy in early childhood education that can better prepare children for the challenges of the 21st century (Tabiin, 2020). The discussion reflects a comprehensive understanding of the impact of the STEAM approach in early childhood literacy development, positioning it as a viable alternative to traditional drill-based methods. The evidence from Az Zahra NU Kindergarten's implementation of this approach provides a compelling case for its broader adoption in educational settings.

Conclusion

This research intricately delved into the design and implementation of a STEAM-based learning approach at AZ Zahra NU Salaman Magelang Kindergarten, with a primary focus on augmenting early childhood literacy skills in reading, writing, and arithmetic, through a contextually rich and meaningful pedagogy. The study unearthed significant insights, revealing that the integration of Science, Technology, Engineering, Arts, and Mathematics into the educational framework profoundly transformed the learning landscape. This transformation was characterized by a shift from traditional, drill-based methods to a more dynamic and engaging approach, leveraging loose-part media and interactive, play-based activities. Such a paradigm shift not only enhanced the holistic developmental aspects of children but also streamlined the educational planning process, allowing educators to focus more on adaptive and child-centric learning strategies. The findings from this singular kindergarten setting, while illuminating, also bring to light certain limitations, primarily the study's focus on a single institution and its reliance on qualitative methods like observations and interviews. These limitations underscore the necessity for future research endeavors to extend across a more diverse array of educational settings, employing a blend of both qualitative and quantitative methodologies, to fully capture the multifaceted impact of the STEAM approach. Moreover, longitudinal studies to assess the enduring effects of this pedagogical shift would be invaluable. Ultimately, the results from Az Zahra NU Kindergarten not only challenge the conventional norms of early childhood education but also strongly advocate for the wider adoption of the STEAM approach, suggesting it as a more effective and engaging pathway for fostering early literacy and comprehensive child development in the 21st century.

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