Reflective Analysis of Mathematical Instructional Activities in Middle-Class at Ningbo National High-Tech Zone Experimental Kindergarten

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Abstract: Early mathematical abilities play a pivotal role in the sustainable development of young children. In the realm of early childhood education, mathematical instructional activities serve as an efficient way for children's mathematical improvement. This research delves into an in-depth analysis of the mathematical instructional activities undertaken within a teaching cycle in the National Experimental Kindergarten of Ningbo High-tech Zone. Considering the mathematical learning and developmental requisites of 4-5-year old children, this study scrutinizes the efficacy and pedagogical significance of the activities conducted within this particular classroom and proposed refined strategies for enhancement

1. Introduction

Early mathematical competency is fundamental to the development of young children. Scholars have underscored that early mathematical proficiency can prognosticate children's subsequent academic achievements, encompassing mathematical skills, literacy skills, non-verbal reasoning, and even their future socio-economic status, where a robust early mathematical foundation correlates with higher social-economic status[1]. Consequently, the enhancement of mathematical skills in young children is garnering heightened attention from academics and practitioners.[2]

Within the ambit of early childhood education, mathematical instructional activities, which encompass both the formal mathematics curriculum and regional games, emerge as the paramount conduit for spurring mathematical development in young learners[3]. The delivery of premium mathematical education is instrumental in promoting the advancement of children's cognition and abilities in this domain. High-quality mathematical instruction and dynamic interaction significantly bolster early mathematical proficiencies as well as the inherent traits requisite for adept engagement in mathematical pursuits.[4]

Concurrently, during the middle childhood phase (4-5 years), children exhibit enhanced physical functions, evincing a heightened preference for observing the world around. Their aptitude for discerning quantities, shapes, and patterns is keener than that of their younger counterparts. This developmental stage encourages them to interpret their surroundings via observation and exploration, thereby presenting myriad opportunities to grasp mathematical concepts. This particular age range bracket is crucial for establishing the foundational principles of mathematics. Engaging young learners in intriguing mathematical endeavors aids in their assimilation of rudimentary concepts, including numbers, shapes, sizes, and sequences, setting the stage for a deeper understanding of intricate mathematical notions in subsequent years.

Nonetheless, current pedagogical approaches manifest inherent limitations, illustrating a divergence between theoretical constructs and their pragmatic implementation. Such limitations impede the optimal nurturing of early mathematical competencies in young learners. Consequently, it is necessary to conduct observational research into the strategies employed in mathematical instruction, assess their effectiveness, and proffer recommendations for enhancement.

This study aims to bridge this gap through observation and reflection on mathematical instructional activities in a classroom at the National Experimental Kindergarten of Ningbo High-tech Zone. Through critical analysis of prevailing teaching methodologies, the research seeks a deeper comprehension of the strengths and pitfalls of mathematical education pertinent to this developmental stage. Through an in-depth exploration of teaching methodologies, effective resource utilization ,and student engagement strategies, this research endeavors to furnish insightful recommendations for enhancing mathematical instruction in early childhood education environments. Ultimately, the overarching purpose is to enhance the caliber of mathematical instruction, cultivate holistic and enriching learning experiences, and contribute to broader discussions within the domain of early childhood education.

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2. Teaching background

In Class 1,the mathematical instructional activities were primarily categorized into two modalities: "Curriculum Activities In the Field of Mathematics" and" Area Activities".

Pertaining to the "Curriculum Activities In the Field of Mathematics", mathematics instruction was scheduled for two of the five weekly sessions. The instructional methodology was anchored in the content of the children's textbooks. The initial session entailed counting the number of circular, triangular, square, and rectangular shapes within a larger composite figure.The subsequent session involved enumerating the sides of various polygons. This instructional approach can be summarized as follows: To commence, the teacher projected a page from the children's textbook via multimedia tools, directing students in the enumeration and analysis of the preliminary pair of queries.. Upon encountering inaccuracies in counting, the instructor offered verbal corrections and reiterated the guidance, posing questions such as, "Could you check if this side is longer than the adjacent one?" Subsequently, pupils embarked on autonomous counting and categorization tasks using their textbooks. As the teacher supervised this independent learning process through observation, direct assistance was offered to only two students, with the main purpose of ensuring guarantee sustained concentration on their assignments and deterring any unrelated discussions.

In relation to the Area Activities, the methodology encompassed the use of dice embedded with addition and subtraction problems within the mathematical area. The fundamental protocol required participants to roll the dice and solve the arithmetic problems corresponding to the face rolled. Contrasted with other area activities, such as role-playing and construction tasks, the mathematical segment seemed deficient in innate allure and remained largely unexplored. Sporadically, a few children would engage with the dice, however, their interaction was typically superficial,mostly observing the dice before placing them back. It is noteworthy that there were no other spatial activities targeting mathematical engagement.

3. Analysis of Teaching Activities

In assessment, the instructional design showcases distinct strengths, albeit accompanied by evident shortcomings.

One of the principal strengths is the alignment of the mathematics classes with Objective 3 "Perceiving Shapes and Spatial Relationships" as outlined in China’s national standard, "Guidelines for Learning and Development of Children Aged 3-6."The pedagogical approach aimed to enhance the children's perception of "the structural characteristics of objects" and their ability to "perceive.identify and classify fundamental attributes of standard geometric shapes" The utilization of multimedia technology enhanced instructional convenience and visual clarity. The teacher conveyed a warm demeanor fostering an encouraging and supportive learning environment.This approach emphasizes humanistic principles, valuing the classroom ambiance and the significance of emotional disposition.

However, several issues emerge:

3.1. Shape Comprehension via Linguistic Mimicry and Recurrent Teacher Emphasis

Throughout the instruction,the teacher consistently accentuated the length of a specific edge. However, there was an evident lack of elucidation or demonstration regarding the rationale behind its increased length.Mechanical repetition and memorization appeared to have misled the children into an apparent grasp of geometric attributes. In fact, it was only a mimicry of the teacher's expressions, rather than a genuine understanding of the comparison of side lengths. Additionally,it was evident when certain children attempted independent shape classification, as they were still struggling to distinguish between squares and rectangles. Furthermore, they didn't proactively apply techniques to compare the lengths of edges.

3.2. Deficiency in Engaging Students and Missing Contextualized Instruction

The classroom's employment of multimedia for mathematical instruction was largely limited to projection tools that mirrored textbook content, thereby not harnessing the comprehensive capabilities of multimedia to infuse the mathematics classes with vibrancy and richness. Notably, the cognitive and contextual learning theory has evolved into a pivotal learning paradigm，promoting not only meaningful learning but also the application of knowledge in authentic contexts[5].

The instruction over the two-day period was strictly confined to textbook content， devoid of avenues for children to engage in hands-on activities or practice.This pedagogical method appeared focused on attaining cognitive objectives, inadvertently sidelining the imperative of stimulating the children's enthusiasm for mathematics. While the appearance of teacher-child interaction prevailed, the children largely adopted the roles of passive recipients, internalizing new information in a rather passive stance. Additionally,with children already accumulating a large number of sensory experiences in their lives, the exclusive dependence on textbook-oriented instruction inadequately supports the transition from perceptual understanding to abstract mathematical cognition, which was disconnected from their actual lives.

3.3. Absence of Individualized and Progressive Pedagogy

The developmental goals proposed in the "Guidelines for Learning and Development of Children Aged 3-6" are broad, and the developmental level of young children is not uniform. Variations stemming from talents, interests, and growth environments manifest as unique learning characteristics, thereby underlining the need for varied instructional strategies to cater to individual

developmental differences. Unfortunately, the teaching content in this classroom was standardized, maintaining a consistent complexity level across problems and exercises. Such uniformity inadequately addressed the diverse developmental needs of the children.

3.4. Complete Autonomy of Operation

Following the instructional demonstration, children may encounter challenges during self-directed learning. Regrettably, the teacher did not provide effective guidance on problem-solving methods. Instead, attention was devoted to maintaining classroom discipline, inadvertently hindering the children's potential breakthroughs in addressing complex problems and acquiring new knowledge. Consequently, the core of the mathematical lessons shifted to autonomous child-led play, devoid of the crucial experiential essence of problem-solving.

3.5. Area Setting Mismatched with Developmental Difficulty, Lack of Contextualization

The specific objectives delineated in the "Guidelines for Learning and Development of Children Aged 3-6" for 4-5-year-olds is to "perceive and comprehend numbers, quantities, and numerical relationships," for instance, understanding that "5 is 1 more than 4" or that "2 combined with 3 equals 5." Upon analyzing these objectives, it is evident that the expectations for middle-class children are to understand numerical relationships within 5 and to understand the meaning of addition and subtraction in practical operation. In contrast, the mathematical domain in Category 1 featured dice containing addition and subtraction problems within 10 that exceeded the developmental goals for middle-class children. This level of complexity was beyond the comprehension of middle-class children and the set-up lacks an entertaining factor, presenting a challenge for children to engage.

Conversely, educational spaces should adopt a game-based design, suffused with amusement to attract children's interest and facilitate practical operations based on their existing knowledge and experiences. Regrettably, this mathematical segment of this classroom neglects this crucial aspect.

4. Strategies and Conclusions

4.1. Individualized Content Development Based on Observational Assessment

Guiding children's mathematical development requires a clear understanding of their current developmental levels. Teachers should make an effort to observe each child during daily activities, group instructional sessions, and spatial games.

Drawing from Vygotsky's Zone of Proximal Development theory, efficacious instruction should consistently precede the child's current stage of development. By observing and assessing each child's current situation, teachers can identify their proximal development zones, enabling the establishment of appropriate instructional challenges that motivate children to transcend their present developmental levels and attain their latent potential[6].

Therefore, the setting of class difficulty should be set slightly beyond the current developmental stages of the children. Moreover, teaching content should encompass diversity and gradients of difficulty from foundational to more profound levels, catering to the diverse developmental requirements of each child.

For instance, integrating diverse activities with autonomous rotation is a potent pedagogical approach. "Diverse activities" refer to a range of operational activities provided to children within the same instructional unit, including "basic activities" centered around the core learning content, "parallel activities" extending their experiential knowledge, "related activities" based on diverse experiences, and "consolidation activities" aimed at solidifying previous learnings.

The concept of"Autonomous rotation" enables children to select activities based on their abilities autonomously, fostering the construction of personalized mathematical concepts and nurturing pertinent problem-solving competencies[6]. This method not only honors the unique learning preferences of each child but also lightens the pedagogical load on teachers, thus promoting more effective personalized instruction.

4.2. Integration of Life Experience: Learning by Doing

The "Guidelines for Learning and Development of Children Aged 3-6" underscore the importance of centering mathematical education in kindergartens around children's operational activities, converting abstract mathematical knowledge into actionable knowledge aligned with children’s capabilities.

Jean Piaget's Constructivist Theory of Cognitive Development highlights that preschool children primarily engage in pre-operational thinking, featuring concrete, image-based cognition. As mathematics is an abstract, highly generalized language that demands logical reasoning, educators must aid children in bridging sensory experiences with rational experiences. For example, in the introduction of mathematical lessons, posing questions grounded in real-life experiences can serve as effective connectors and spark children's inquisitiveness for learning.

Subsequently, leveraging multimedia tools to showcase real-life shape examples proves to be beneficial. Simple everyday items like marbles and tangram puzzles can serve as engaging instruments. Throughout this process, children engage in hands-on exploration, observe tangible objects, and enhance their personal perceptual experiences. This incorporation of teacher-led demonstrations, textbook exercises, and children's hands-

on comparisons amplifies the richness of the instructional experience.

4.3. Effective Implementation of Corner Activities

4.3.1 Supportive and Complementary Role:

Regional activities serve to reinforce and extend collective teaching sessions. The freedom of form and adequate time allocation in regional activities provide a platform for personalized guidance that group instruction might not accommodate[7].

4.3.2 Engaging Materials

Materials introduced in regional activities should integrate entertainment and educational value.

4.3.3 Guided Exploration:

Regional activities should be conducted under the effective guidance of teachers.

For instance, when the instructional emphasis is on shape differentiation and classification, the teacher can furnish the area with an assortment of interesting tangible toys embodying distinct ,complemented by sorting containers. This method encourages children to engage in categorization activities of varying levels of complexity,satisfying their developmental needs.Throughout this activity, teachers ought to offer appropriate guidance without disrupting independent exploration. Effective questioning could be employed, given that mere operational actions might not capture the entirety of a child's cognitive progression. For illustration, when two children have successfully categorized objects, the teacher can ask , "How did you categorize them?" Children's answers frequently reflect their different cognitive processes,such as some saying "one by one," while others say "similar shapes are placed together. At this point, the comparison of the classification results of two children can redress incorrect methods,unconsciously forming the concept of “class” in their minds by highlighting the merits of observation rather than randomly placed.Questioning serves a great tool for children’s reflection, mutual learning, deliberate categorization based on characteristics, and assists teachers in gauging the extent of children's comprehension of mathematical concepts[8].

4.3.4 Communication and Summation

At the culmination of a learning phase, engaging in communication and summation is necessary to consolidate the acquired knowledge. A reasonable assessment determines the efficacy of instructional methods, clarifies subsequent adjustments, and upholds educational quality. The assessment of area activities ought to transition from a singular focus on outcomes, accentuating the underlying process instead. A diverse array of assessment techniques should be employed to bolster children's progression within mathematical area activities[9].

Teachers can evaluate both the process and outcomes separately. Process assessment serves as an incentivizing instrument, encouraging children's continued interest in exploration. Outcome assessment paves the way for subsequent activity planning and enhancement of teaching quality. Furthermore, in line with humanist scholar Carl Rogers' perspective, prioritizing children's self-assessment is paramount. Steering children towards introspective reflection on their learning fosters awareness of self-developmental levels, enhances confidence, and cultivates their articulative proficiencies..

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