

Fine Motor Urgency as the Foundation of Early Childhood School Readiness

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ABSTRACT. Fine motor skills are a critical component of early childhood development that directly underpins school readiness. However, their stimulation in Indonesian early childhood education (PAUD) institutions remains inconsistent and non-systematic. This study aims theoretically examines urgency of fine motor development as a foundation for early childhood school readiness through a library research approach. Primary data were drawn from three developmental psychology texts by Santrock , Hurlock , and Gallahue & Ozmun while secondary data were sourced from Scopus and SINTA 1–3 indexed journals published between 2020 and 2025. Data were analyzed through content analysis combined with literature synthesis. The findings reveal that fine motor skills operate through three sequential pathways: strengthening social-emotional readiness, enhancing cognitive coordination and concentration, and forming the biological prerequisite for beginning writing ability. These developmental processes are grounded in Vygotsky's Zone of Proximal Development, Piaget's sensorimotor theory, and Gesell's biological maturation theory, respectively. This study affirms that structured fine motor stimulation constitutes a long-term investment in children's school readiness. Practically, these findings urge PAUD educators and policymakers to integrate structured fine motor stimulation programs into the early childhood curriculum as a non-negotiable foundational priority.

Keywords: Fine motor skills, school readiness, early childhood, early childhood education, developmental psychology

INTRODUCTION

Learning readiness is a fundamental prerequisite that determines the success of children in undergoing the formal education process. Santrock (2011) defines learning readiness as a condition of overall maturity that includes physical, cognitive, social, and emotional aspects that allow children to participate optimally in learning activities. A phenomenon that is often found in the world of education shows that many children who enter the first grade of elementary school do not have adequate readiness. Hurlock (1978) reminded that learning unpreparedness at early school age is not only a cognitive problem, but is greatly influenced by the physical-motor maturity that should have been built from an early age. This condition is a serious concern considering that weak learning readiness at the beginning of education has the potential to cause academic obstacles that continue to a higher level (Cameron et al., 2012). Early childhood, which ranges from zero to six years, is widely recognized in developmental psychology as the golden *age*. In this phase, the child's brain experiences the most rapid development and is most responsive to various forms of environmental stimulation (Papalia & Feldman, 2012). Sujiono (2009) emphasized that all potential for child development, including motor, language, cognitive, and social-emotional aspects, was fundamentally formed and consolidated in this period. Therefore, the quality of stimulation provided during the *golden age* will have a much more significant long-term impact than interventions carried out at a later age. This makes early childhood education the most strategic arena to build the foundation of learning readiness in a holistic and sustainable manner.

Among the various aspects of early childhood development, fine motor is a component that has a direct correlation with formal learning readiness. Gallahue and Ozmun (2006) define fine motor as an ability that involves the coordination of small muscles, particularly in the fingers and wrists, that work in an integrated manner with the visual system. These abilities include activities such as holding pencils, scissors, folding paper, and knitting beads, all of which are pre-academic skills that children need in formal learning (Sumantri, 2005). Despite its very important role, fine motor often receives less attention than gross motor in early childhood learning programs (Sanenek et al., 2023). In fact, research proves that children who have good fine motor skills before entering elementary school show higher academic achievement, especially in reading and math skills (Grissmer et al., 2010). A UNICEF Indonesia report (2022) states that early childhood access to quality early childhood education services in Indonesia is still limited, and most existing institutions do not have structured motor stimulation guidelines. In line with that, the Ministry of Education, Culture, Research, and Technology (2023) noted that the physical-motor development aspect in PAUD still does not receive a proportionate portion compared to the cognitive and language aspects, so that many children enter the elementary school level without adequate motor readiness. Recent findings from Cinar et al. (2023) on 832 children aged 6–7 years reinforce the relevance of this issue by proving that fine motor significantly predicts children's vocabulary ability, numerical knowledge, and attention skills, confirming the urgency of structured fine motor handling in Indonesian PAUD institutions.

Previous studies have attempted to examine the relationship between fine motor skills and children's learning readiness, but the results show that the direction is not completely uniform. Grissmer et al. (2010) unequivocally concluded that fine motor is a very strong and even more predictive indicator of school readiness than a number of other cognitive indicators, a finding corroborated by Karimi et al. (2025) who found that fine motor is able to predict up to 46% of preschoolers' learning readiness variance. Different from this conclusion, Cameron et al. (2012) found that fine motor cannot completely stand on its own because executive function has been shown to contribute equally greatly, so the two need to be seen as a unit in building comprehensive learning readiness. On the other hand, studies from the Indonesian context show a different orientation. Sanenek et al. (2023) found that although the understanding of the importance of fine motor skills continues to develop, the implementation of stimulation in PAUD institutions is still carried out incidentally and has not been integrated into the curriculum in a structured manner. Other studies in Indonesia have focused more on specific activities as an effort to improve fine motor, but have not reached a broader discussion of how fine motor function as a theoretical foundation for overall learning readiness (Hefniy et al., 2022; Noor, 2023). This gap is further evident from the fact that most early childhood research in Indonesia is still dominated by empirical approaches based on classroom actions or experiments, while conceptual studies that synthesize developmental theoretical perspectives on fine motor urgency as a foundation for learning readiness are still very limited, so educators and policymakers have difficulty finding a strong theoretical foundation to design targeted stimulation programs. Based on these gaps, this article is here as an effort to fill the space for study that is still limited. This article aims to theoretically examine the urgency of early childhood fine motor development as a foundation for learning readiness by synthesizing perspectives from various relevant theories and literature on child development. Through a systematic literature review approach, this study is expected to make a meaningful conceptual contribution for early childhood educators, parents, and policy makers in understanding and prioritizing fine motor stimulation as an integral part of early childhood education programs in Indonesia.

METHOD

This research is a library *research* that uses written sources as the main data. Primary data is sourced from three books on child development psychology that are the basis of the main theory, namely *Child Development* by Santrock (2011), *Child Development* by Hurlock (1978), and *Understanding*

Motor Development by Gallahue and Ozmun (2006). The three books were purposively selected based on their relevance to the topic of fine motor early childhood and their internationally recognized authority. Secondary data was obtained from articles of scientific journals indexed by Scopus and SINTA 1 to SINTA 3 which were accessed through Google Scholar and the official website of scientific journals in the last five years, namely 2020 to 2025. The literature search was conducted using the keywords "early childhood fine motor skills," "early childhood learning readiness," "early childhood fine motor skills," and "school readiness fine motor skills." The inclusion criteria include articles that discuss fine motor development in the context of early childhood education, written in Indonesian or English, and accessible in full text. Literature that is not directly related to the topic and that is not fully available was excluded from the study. The collected data is then analyzed using *content analysis* techniques to identify and classify key ideas from each source, which are then combined with the synthesis of the literature to build an integrated and comprehensive conceptual argument. The literature selection process refers to the *PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)* flow, which includes the identification stage, screening by title and abstract, feasibility assessment based on full text, and assignment of included articles. Of the total literature searched, as many as 28 scientific articles were declared to meet all inclusion criteria and were used as secondary data sources in this study. The validity of the synthesis is ensured through cross-reference triangulation of sources and the verifiability of arguments, so that each conceptual argument constructed has a verifiable foothold from more than one independent source.

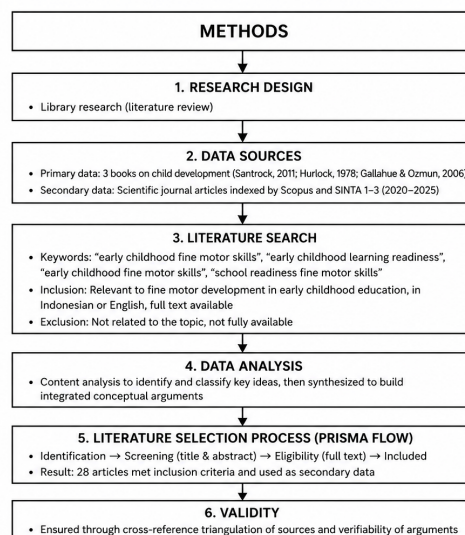


Figure 1. Methods

RESULT AND DISCUSSION

Concept of Fine Motor in Early Childhood

Fine motor refers to the ability to move that involves the coordination of small muscles in the body, especially those found in the fingers and wrists. Gallahue and Ozmun (2006) define fine motor skills as abilities that require control, precision, and coordination between hand movements and vision synergism. In line with this, Hurlock (1978) stated that fine motor is the mastery of movements that use small muscles and demand high precision, such as cutting, drawing, and writing. Sumantri (2005) added that in the context of early childhood education, fine motor includes all manipulative activities that train finger coordination as a basic pre-academic skill of children. From these various definitions, it can be concluded that fine motor is the ability to make precise movements that are centered on finger-wrist-eye coordination and become the foundation for mastering academic skills at the next level. Early childhood fine motor development includes three main aspects that work in an integrated manner. First, eye and hand coordination that allows

children to control hand movements based on the visual information received, such as when tracing patterns, coloring within line boundaries, or moving small objects to the intended location. Second, the strength and precision of the fingers that support the activities of grasping stationery, scissors, and knitting with increasing precision as we age. Third, wrist flexibility that allows children to perform movements of twisting, folding, and rolling certain materials flexibly (Gallahue & Ozmun, 2006). These three aspects do not stand alone, but support each other and are a prerequisite for mastering children's academic skills in elementary school. Sari and Hidayah (2021) show that mosaic activities that combine these three aspects simultaneously have been proven to have a significant influence on the fine motor development of group B kindergarten children, especially in practicing finger coordination and precision of movement.

Fine motor development takes place gradually according to the level of physical and neurological maturity of the child. At the age of zero to one year, children begin to grasp objects reflexively which then develop into more directed and deliberate grasping. At the age of one to three, children are able to hold stationery with their fists full of hands and begin to make irregular scribbles on paper. By the age of three to four, children can already cut straight lines and draw simple circle shapes. In the age range of four to five years, finger coordination is increasingly honed so that children are able to color within the boundaries of the pattern more neatly. By the age of five to six, children have demonstrated fine motor skills that are mature enough to write simple letters and complete manipulative activities with good control (Hurlock, 1978; Sumantri, 2005). Józsa et al. (2023) confirmed through cross-country studies that fine motor development is a multifactorial process influenced by age, gender, and cultural context, so appropriate stimulation needs to take into account the individual variability of the child and cannot be artificially standardized. Children's fine motor development is inseparable from a number of complementary developmental theories. Piaget through his theory of cognitive development places the sensorimotor phase, which lasts from the age of zero to two years, as the starting point for the child to understand the world through movement and senses. In this phase, motor experiences, including fine motor skills, become the first bridge between the physical world and the formation of the child's cognitive schema (Santrock, 2011). With a different emphasis, Gesell emphasized that biological maturity is the main prerequisite for motor development. Children cannot be forced to master certain motor skills before their nervous system is sufficiently mature, so stimulation must always be adjusted to the stages of biological maturity of each child (Hurlock, 1978). Meanwhile, Vygotsky through the concept of *Zone of Proximal Development* (ZPD) shows that children can develop their fine motor skills optimally if they receive guidance from more skilled adults or peers (Papalia & Feldman, 2012). Sutapa et al. (2021) reinforce this Vygotsky perspective by proving that planned, goal-oriented play activities for twelve weeks significantly improve the motor skills of children aged 4.5 to 6 years, confirming that the quality of guidance and stimulation programs greatly determines the achievement of motor development. These three theoretical perspectives together affirm that fine motor development is multidimensional and requires an approach that pays attention to biological maturity as well as the quality of environmental stimulation.

The Concept of Early Childhood Learning Readiness

Learning readiness is a condition that allows children to be actively and successfully involved in the formal learning process. Santrock (2011) defines learning readiness as maturity that includes physical, cognitive, language, and social-emotional aspects that work simultaneously in children. Papalia and Feldman (2012) added that learning readiness is not just the ability to follow academic instruction, but includes overall readiness to adapt to the school environment, build social relationships, and manage oneself independently. Hurlock (1978) emphasized that learning readiness must be seen as a dynamic and individual construct, where each child has a different rate of maturity depending on his biological and environmental factors. Thus, learning readiness must be understood as a multidimensional construct that is the result of the integration of all aspects of child development as a whole. Early childhood learning readiness is built by four dimensions that

are interrelated and inseparable from each other. The physical-motor dimension includes general body maturity as well as motor abilities, both gross and subtle, that support the child's involvement in direct learning activities. The cognitive dimension includes the ability to think, remember, solve simple problems, and understand basic concepts. The language dimension includes the ability to listen, understand verbal instructions, and express thoughts orally. The social-emotional dimension includes the child's ability to cooperate, manage emotions, tolerate frustration, and build positive relationships with teachers and peers (Santrock, 2011; Papalia & Feldman, 2012). These four dimensions work in an integrated manner so that weaknesses in one dimension have the potential to hinder development in the other.

A number of indicators can be used to identify children's learning readiness when entering elementary school. From the physical-motor dimension, children are considered ready if they are able to hold stationery in the right way, cut according to a simple pattern, and complete basic manipulative tasks independently. From the cognitive dimension, children are expected to recognize letters and numbers and be able to follow instructions two to three steps in a row. From the language dimension, children should be able to listen to short stories and express their thoughts in sentences that are quite clear. From the social-emotional dimension, children are expected to be able to share with friends, wait their turns, and follow the rules of the classroom (Hurlock, 1978; Cameron et al., 2012). A longitudinal study by Kamphorst et al. (2021) strengthens this by proving that children who have a good motor skills profile since kindergarten show more positive learning outcomes on the cognitive and social-emotional dimensions in the first grade of elementary school, indicating that motor readiness and learning readiness are two inseparable constructs.

Fine Motor Urgency as a Foundation for Learning Readiness

Fine motor skills are closely related to children's social-emotional readiness as the broadest dimension of learning readiness. Well developed fine motor skills give children the confidence to be actively involved in various activities together, such as making group crafts, playing constructively, and completing tasks in pairs. When a child is able to cut, paste, and color with satisfactory results, he or she is likely to show positive expression and courage to participate more actively in the classroom (Sanenek et al., 2023). In contrast, children with fine motor impairment often avoid manipulative tasks, withdraw from interactions with peers, and show frustration that leads to unproductive behavior. Papalia and Feldman (2012) emphasized that children's motor competence contributes significantly to self-image and self-confidence in the social environment, so that children who are motor skills tend to be more easily accepted in play groups and have more mature social-emotional readiness to enter the formal school environment. Kuraedah and Anhusadar (2020) show that pleasant fine motor stimulation through materials close to a child's life has been shown to be effective in increasing children's motivation and confidence, which indirectly strengthens their social-emotional readiness. This linkage is in line with the concept of ZPD Vygotsky which places social interaction as the main medium of the development of children's abilities, including fine motor skills. In more specific dimensions, fine motor also plays an important role in supporting children's cognitive coordination and concentration abilities. Fine motor activities such as putting together puzzles, meronce, and folding origami require children to concentrate, follow the sequence of steps systematically, and control impulses of motion simultaneously. This process indirectly trains the child's executive function, namely the ability to plan, monitor, and evaluate the actions being carried out (Cameron et al., 2012). Grissmer et al. (2010) found that fine motor skills measured when children enter kindergarten are strong predictors of academic achievement in reading and mathematics through the fifth grade of elementary school. Cinar et al. (2023) expanded on these findings through a study of 832 children aged 6-7 years and found that fine motor significantly predicted a child's vocabulary ability, numerical knowledge, and attention skills when entering school, with even stronger association strength in girls than in boys. These findings reinforce Piaget's perspective that sensorimotor

experiences, including fine motor activity, directly shape a child's cognitive schema that is the foundation for effective thinking and learning abilities (Santrock, 2011).

The culmination of fine motor urgency as a foundation of learning readiness is most evident in the ability to write initially, which is the most fundamental academic skill in elementary school. Writing is an activity that directly depends on fine motor qualities, as it requires precise coordination between fingers, wrists, and eye movements towards the writing field (Gallahue & Ozmun, 2006). Children who do not have sufficient finger strength and eye-hand coordination will have difficulty holding the pencil correctly, forming letters in appropriate proportions, and writing within the available line limits. Hurlock (1978) emphasized that poorly developed writing skills not only hinder writing skills themselves, but also affect the overall speed and quality of learning. Isnaini and Katoningsih (2022) identified that the biggest problems in improving the fine motor skills of children aged 5-6 years in early childhood education institutions are the lack of practical guidance for educators and the limitations of learning media specifically designed to prepare for initial writing skills. In Gesell's perspective, the readiness to write cannot be forced before the biological maturity of the child's nervous system and fine muscles is completely achieved, so fine motor stimulation in the early childhood education period should be seen as the most basic and unskimping biological preparation. Based on the description of the three subtle motor urgency pathways above, all the conceptual arguments that have been built in this study can be visualized in their entirety through the conceptual framework in Chart 1. The chart illustrates the flow of fine motor influence on learning readiness systematically from top to bottom. At the top layer, three theories of development are placed as the theoretical foundation that underlies this entire framework. Piaget, with sensorimotor theory, emphasized motor experience as a vehicle for early cognitive formation. Gesell emphasizes biological maturity as a prerequisite for stimulation. Vygotsky with ZPD places social interaction as a driver of development. From the theoretical foundation, the groove leads to the Fine Motor box as the main variable, which is broken down into three core aspects: eye-hand coordination, finger strength and precision, and wrist flexibility. These three aspects then branch out through three urgency paths towards the three dimensions of learning readiness. The first path to Social-Emotional Readiness (Vygotsky-ZPD), the second path to Cognitive Readiness and Concentration (Piaget-Sensorimotor), and the third most concrete path to Initial Writing Ability (Gesell-Biological Maturity).

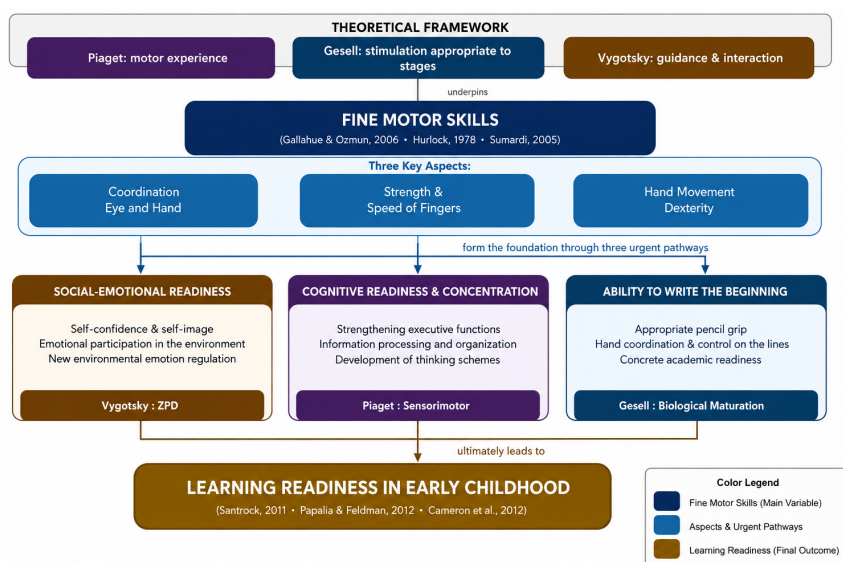


Figure 2. Conceptual Framework of Fine Motor Urgency as a Foundation for Early Childhood Learning Readiness

Figure 2 shows two main conceptual contributions of this study. First, fine motor works through three pathways that move progressively from the broadest dimension, namely social-emotional readiness, to increasingly specific, cognitive readiness, to the most concrete, the ability to write initially. This sequence reflects the logic of child development that moves from affective to academic. Second, the theories of Piaget, Gesell, and Vygotsky, which have often been seen as separate, in this framework are complementary and each illuminates a different path of urgency precisely. An understanding of fine motor urgency should drive real change in early childhood education practices. First, at the educator level, PAUD teachers need to design activities that are directed to practice finger and hand coordination, such as playing playdough, scissors, meronce, and drawing. Nasution and Sutapa (2021) identified that teachers' strategies in stimulating motor skills greatly determine the quality of children's motor development, but many teachers face limitations in designing structured and varied activities without adequate guidance. Dwi et al. (2022) offer a solution through the innovation of the ATIK model, a fine motor stimulation approach that is integrated in early childhood learning and has been proven to provide more optimal results than motor activities carried out incidentally. Second, at the family level, parents need to be actively involved in fine motor stimulation at home through daily activities such as folding clothes, buttoning, and making simple crafts with children, because the home environment is the first and most intense stimulation space (Hefniy et al., 2022). Third, at the policy level, education policy makers need to ensure that aspects of fine motor development receive a proportionate portion in the early childhood education curriculum. With synergy between the school environment, family, and policy, fine motor stimulation can be optimized as a solid foundation for learning readiness for every early childhood in Indonesia.

In addition to these three urgency pathways, it is also important to consider the mediator and moderator factors that affect the strength of the link between fine motor and learning readiness. Cameron et al. (2012) identified that executive function plays an important role as a mediator in the relationship between fine motor and children's academic achievement, so a good intervention needs to train both simultaneously. The quality of the family environment, including the frequency of parent-child interaction and the availability of fine motor play materials at home, has been shown to be the moderators that determine the effectiveness of stimulation (Hefniy et al., 2022). Nasution and Sutapa (2021) added that the competence and creativity of PAUD teachers in designing fun and structured motor activities function as mediators between children's fine motor skills and their learning readiness achievements. By understanding the role of these mediator and moderator factors, educators and policymakers can design interventions that are more targeted and pay more attention to the variability of each child's context.

CONCLUSION

This study confirms that fine motor is the multidimensional foundation of early childhood learning readiness that works through three mutually reinforcing pathways: social-emotional readiness through the reinforcement of confidence and social competence (ZPD Vygotsky), cognitive readiness and concentration through executive function training (Piaget's sensorimotor), and the ability to write beginning as the most concrete biological prerequisite (Gesell's biological maturity). These three theoretical perspectives do not contradict each other, but rather complement each other in explaining the different dimensions of the same phenomenon, as visualized in the conceptual framework proposed by this study. The implications of this study cover three main levels. At the educator level, PAUD teachers need to integrate fine motor stimulation in a structured and evidence-based manner in their daily learning plans, shifting the paradigm from incidental activities to planned programs. At the family level, parents need to be involved as active partners through meaningful daily activities at home. At the policy level, fine motor needs to receive a proportionate portion in the national early childhood education curriculum, equivalent to cognitive and language aspects. Further research is encouraged to empirically examine the

effectiveness of structured and contextual fine motor stimulation programs in early childhood education institutions in Indonesia.

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