



The Skill Gap: Disconnect Between Applied & Academic Math in Children

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INTRODUCTION

- In a bustling market in Kolkata, the clamor of daily transactions reveals an unexpected narrative about mathematical proficiency. A groundbreaking study by Banerjee et al. (2017) unveils that children working in these informal settings exhibit an extraordinary ability to solve arithmetic problems in real time. When faced with market transactions, an impressive 87.6% of these children calculated the total amount correctly in the first round—an ability that rose to 91.5% in the second round and 90.5% in the third. Yet, when the very same arithmetic was abstracted into a written test, only 32.3% of the children reached what the study defines as the “division level,” with a further 21.4% classified at the “subtraction level.”
- These statistics point to a profound disconnect: the children’s skills are not absent but are instead finely tuned to the context in which they operate. On the bustling floor of a market, where each calculation could mean the difference between profit and loss, the children’s mental arithmetic flourishes. They perform dynamic, multi-step calculations without the luxury of pen and paper, relying on a logic that is both fluid and adaptable. In stark contrast, the same children struggle when asked to engage with the sterile, abstract arithmetic problems typical of school assessments.

- This divergence calls into question the efficacy of an education system that prizes formal, algorithmic approaches over the intuitive problem-solving that real-life situations demand. If 88 to 92 percent of market-working children can accurately compute transaction totals on the fly, then the failure observed in classroom settings may be less about the children's inherent abilities and more about the disconnect between academic math and practical arithmetic. The study, which surveyed 201 children across 92 informal markets, challenges educators to rethink how math is taught. Instead of isolating numerical exercises within the four walls of a classroom, there is an urgent need to weave together real-world problem-solving with formal academic structures.
- By integrating simulations of everyday transactions into the curriculum where a subtraction problem is reimaged as the process of returning change, or a division exercise becomes an estimation of cost per unit, the education system could harness these untapped skills. Such an approach would not only validate the arithmetic competence these children already display but also bridge the gap between the practical and the abstract. In doing so, math education could evolve into a tool that equips all students to navigate the complexities of everyday life with the same assuredness that these young market vendors demonstrate daily.

Duality of Mathematics: Intuitive vs Formal

- Intuitive mathematics is the conceptual understanding of math problems developed through practice in real world settings, generally developed by solving applied market math problems.
- Intuitive mathematics is based on gut-feeling and is devoid of the algorithmic approach followed in formal mathematics prescribed in accordance with the educational curricula.
- The approach in formal mathematics is to solve abstract math problems used by school children. It relies on formula-based and algorithmic techniques.
- A key theory in cognitive psychology posits that learning mathematics in real-world contexts enhances classroom instruction, fostering more generalizable and flexible arithmetic skills in children.

- In formal schooling the students stick to pen and paper, in an experiment it was observed that in a real-world context non-working school children repeat the same steps and take longer to complete the mathematical problems whilst lacking the skill to combine multiple operations.
- It was also observed that students of school make inefficient mathematical calculations when given a real-world problem.
- In a survey of 201 children working in markets of Kolkata it was observed that they are effective and competent of doing complex arithmetic which is not based on rote memorization, but they fail at solving abstract math problems.
- In a survey of 200 government school students of Delhi, it was observed that school students failed to solve concrete problems.
- The skills acquired in these two mathematical styles are not transferable across domains and their performance varies according to context.

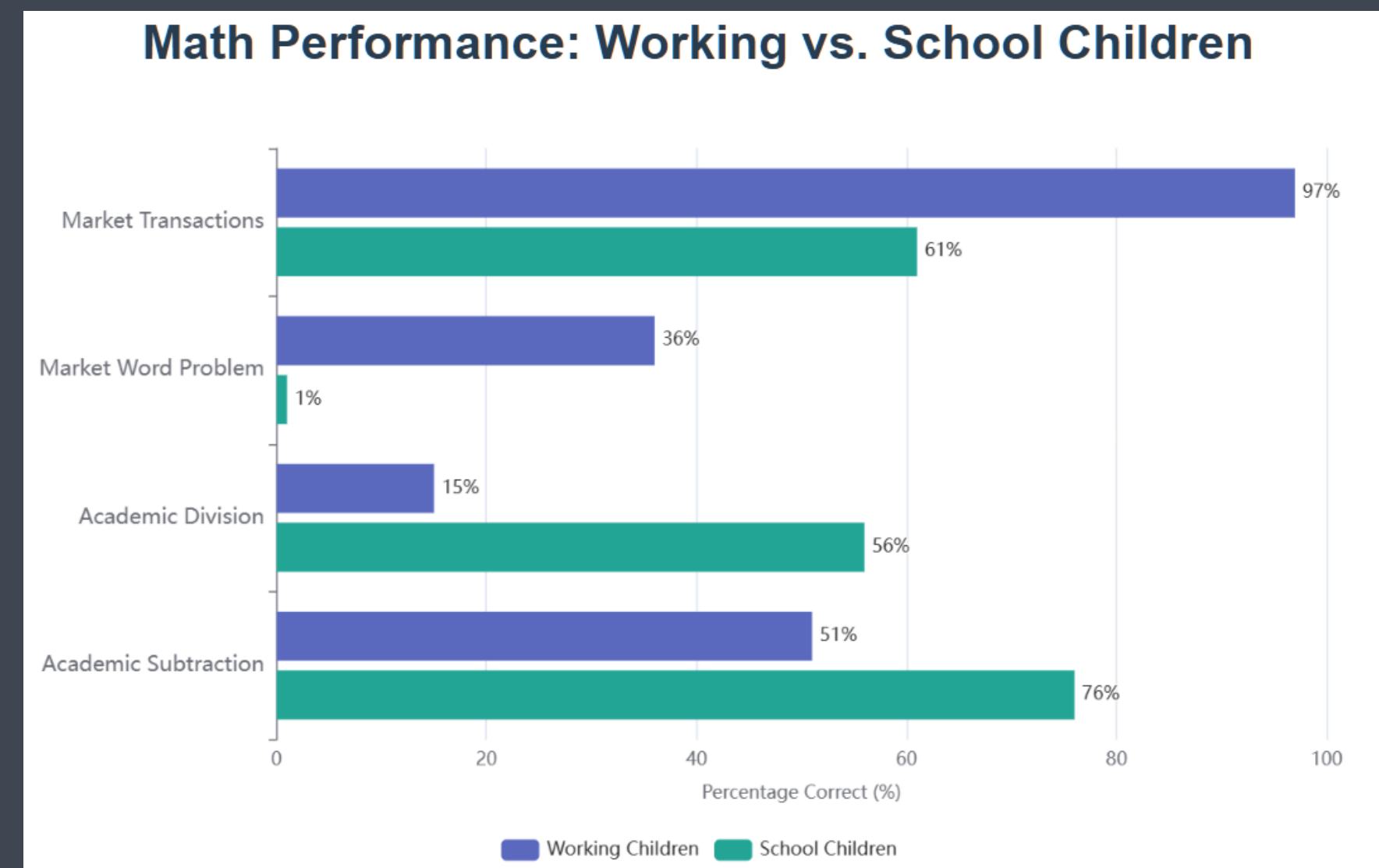
Barriers to Reform: Why Change is Difficult

- Mathematics education in India remains rooted in traditional methods that prioritize rote memorization over conceptual understanding. This approach continues due to a rigid curriculum, an exam-centric culture, resistance to pedagogical innovation, socio-economic issues and gaps in teacher training.
- **Exam-Driven Culture:** The education system heavily prioritizes board examinations and other outdated assessment techniques, which mainly assess procedural knowledge rather than analytical or problem-solving abilities.
- **Low Pedagogical Content Knowledge (PCK):** Many mathematics teachers struggle with advanced problem-solving techniques and fail to integrate real-world applications into their teaching. Studies from NITI Aayog (2021) suggest that many teacher training programs remain focused on outdated teaching techniques rather than equipping educators with innovative pedagogical tools like visualization tools, gamification, and coding. The ASER Reports (2018-2023) consistently highlight that rural schools often lack qualified mathematics teachers. Many teachers are assigned to teach mathematics despite lacking sufficient subject-matter expertise

- **Unequal Access to Resources:** Rural and low-income students lack access to quality textbooks, digital tools, and skilled teachers. The *ASER Reports (2018-2023)* show that students from marginalized backgrounds consistently underperform due to inadequate school infrastructure. Cultural stereotypes discourage girls from pursuing mathematics, particularly in conservative rural areas. Reports from *UNICEF (2020)* indicate that despite improvements in urban settings, girls still face structural barriers in STEM education.
- The *National Education Policy (NEP) 2020* has laid the groundwork for integrating conceptual learning in mathematics, but implementation remains inconsistent across states. Digital interventions, such as gamification, blended learning, and coding-based mathematics education, are being explored. However, these remain largely inaccessible to rural students due to the digital divide.

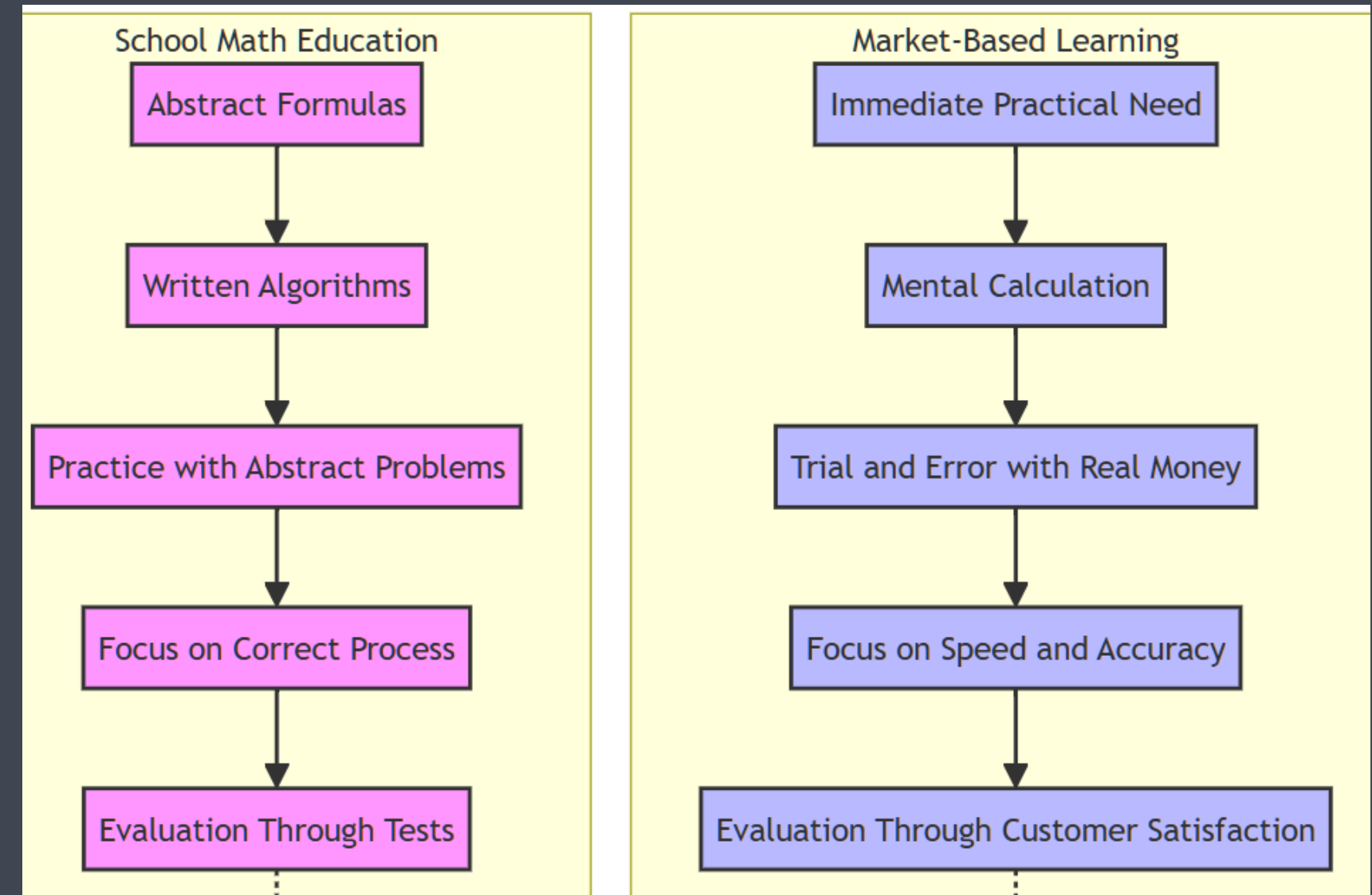
Limitations of Rote Learning: The Disconnect Between Intuitive and Formal Mathematics

- Market children showed 95-98% accuracy in real transactions but only 15-32% success on equivalent abstract problems
- Performance declined as problems moved away from familiar contexts (96% → 61%), revealing lack of adaptable problem-solving skills
- India's math education prioritizes procedural knowledge over conceptual understanding
- Rigid instructional approaches prevent connecting intuitive math skills with formal mathematical concepts
- Study demonstrates direct consequences of colonial-era focus on computational accuracy over mathematical reasoning



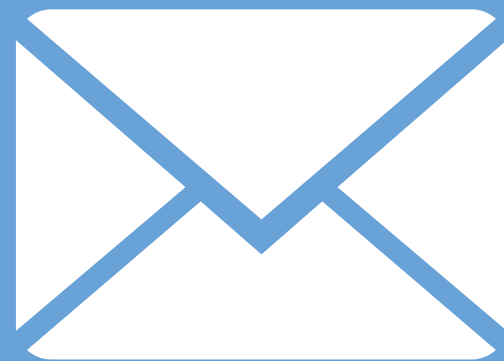
The Exam-Centric Model

- JEE and board exams shape instruction toward memorization over reasoning
- School children achieved 56% accuracy on abstract problems but only 1% could solve practical market word problems
- 96% of school children relied on written algorithms vs. 0% of market children for identical calculations
- Excessive written work (average 102 numbers, 22 operations) shows emphasis on "showing steps" rather than efficiency
- Students taught what to do but not why, evidenced by inability to transfer skills between contexts
- Applied knowledge gap reflects examination system that rewards procedural accuracy over conceptual flexibility



Socioeconomic Divide – Math as a Marker of Inequality

- **Divergent Skill Development:** Working-class market children developed strong mental arithmetic (95-98% accuracy) through real-world experience, while middle-class school children excelled in formal notation but struggled in applied settings (only 60% success in pretend market transactions).
- **Context-Dependent Learning:** Market children performed 8% better on problems anchored to familiar settings, but their accuracy dropped from 96% to 61% as problems moved away from real-world contexts. Conversely, school children performed 6% worse when problems were framed in applied terms.
- **The Failure of Bridging Attempts:** Providing hints, incentives, and problem breakdowns did not significantly improve performance in either group. This suggests that mere exposure to different formats is insufficient—deep cognitive restructuring is needed.
 - **Education as a Reinforcer of Inequality:** The inability of school children to apply math in real-world contexts leaves them ill-equipped for informal economic activities (e.g., entrepreneurship, day-to-day financial management).
 - Meanwhile, working children's skills remain locked in specific domains, preventing access to higher mathematical learning needed for social mobility (e.g., formal employment, STEM fields).
 - This two-way failure reflects an educational system that neither values practical intelligence nor teaches abstract problem-solving effectively.
- **Bridging the Gap:** The study calls for a fundamental pedagogical shift—curricula must integrate intuitive, experience-based numeracy with formal instruction to ensure both social and economic mobility across class lines.



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